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Technology Review

Edited at the Massachusetts Institute of Technology



The Commercial Promise of the Shuttle

American Partners and Competitors in the Sky: China, Japan, the USSR, and a European Alliance

Space Futures: An Active Market for the Imagination

Space Weapons: In Dubious Battle

BIG DEALS IN SPACE

technology
review
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Volume 84, Number 1
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Technology Review

SPECIAL ISSUE: BIG DEALS IN SPACE



Cover photograph by Raycroft/McCormick Photography; Design by Nancy C. Pokross

34 Implications of the Shuttle: Our Business in Space
by Jerry Grey
The airplanelike reusability of this new spacecraft brings us to an entrepreneurial frontier in space.

50 Dragon in the Sky: China's Space Program
by David Ritchie
While following Maoist tradition of relying on one's own resources, China has demonstrated its attractiveness as a partner.

56 The Ultimate Battleground: Weapons in Space
by Gerald Steinberg
The exotic hardware of *Star Wars* would in reality be expensive, impractical, and politically destabilizing.

64 A Youthful Platform for Space
An upbeat view of space from Europe's children—light on violence, heavy on the optimism and richness of youthful imagination.

68 Space Technology: Where Will Fiction Meet Reality?
by Giuseppe Colombo
To Jules Verne, a rocket to the moon was a mind-boggling feat of fiction. So must today's fiction become tomorrow's reality.

37 Spacelab: Whence and Whither?
by Kenneth Owen
The European Spacelab will be cargo on the space shuttle, but . . .

6 Europe's Launching Space Business
by Robert C. Cowen
. . . Europe's Ariane launcher may soon be a commercial alternative to reckon with.

32 The Soviet Space Program: Will Expendable Be Beautiful?
by Thomas J. Frieling
The Soviet booster strategy: disposable but reliable.

48 The Japanese Empire Strikes Back
by Masayoshi Kanabayashi
Will the Japanese do for reusable spacecraft what they've done for automobiles and electronics?

TRENDS

78 Environment | **79 Fundamentals** | **80 Engineering Education** | **82 Managing** | **84 Transportation** | **85 Last Line**

COLUMNS

4 The Echo Stops Here
Kenneth Boulding
Shouting "peace" instead of "war" may produce reverberations of a different color.

8 The Media:
Mark Bowden and Jennifer Trainer
Neither the assurances of nuclear advocates nor the condemnations of opponents will do. Just assume an intelligent audience and give 'em the facts.

12 Forum:
Edward Teller
Secrecy may well be more of a bane to productivity than a boost to security.

18 Landscaping to Save Energy
Ruth S. Foster
Passive can be beautiful, literally.

26 Books and Comment
Red Star in Orbit, reviewed by Charles Ball; *Being Human in a Technical Age*, reviewed by Miles Orvell; *Human Nature and History: A Response to Sociobiology*, reviewed by Jon Beckwith; *Genes, Mind, and Culture*, reviewed by David Layzer.

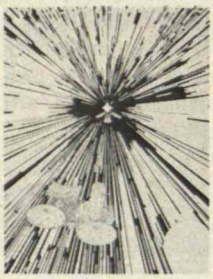
DEPARTMENTS

2 First Line | **3 Letters** | **86 Reporter**

FIRST LINE

Technology Review Goes Far Out

Welcome to what is virtually a special issue inspired by the next scheduled space shuttle launch later this month. In the words of Jerry Grey (*see "Implications of the Shuttle: Our Business* in Space," p. 34), this vehicle represents "the most significant milestone in space flight: the advent of airplane-like reusability."



Hyperspace Jump*, by 15-year-old Mark R. E. Jones of the United Kingdom. *(See "A Youthful Platform for Space" on page 65.)

To space proponents like Grey (and many other authors in this issue), exploration and exploitation of the heavens is an exciting, perhaps the ultimate, technological adventure. But, like all technological enterprises, it has important economic, political, sociological, intellectual, and moral ramifications. Technology, after all, whether on earth or in space, has many faces.

Grey's article is less about the nuts and bolts of the shuttle than about the industrialization of space it could help to create. Gerald Steinberg describes the possible military uses of space, also extended by the shuttle, endeavoring to sort fact from fancy. David Ritchie reports on China's space program—a small but potentially strong influence on the commercial and military plans of the superpowers. Giuseppe Colombo looks further into the future of space technology for some "blue-sky" extrapolation from the shuttle: to mines on the moon and beyond.

Complementing these feature articles is an array of shorter pieces: on Europe's Spacelab (which will ride on the shuttle), Europe's launcher *Ariane* (which may *compete* with it), Japan's ambitions to do for space industry what it has done for cars and television sets, the Soviet experiences and likely agenda in space, the view from Washington, and some uninhibited visions of our future in space from children.

Our aim is not only to celebrate the shuttle but to transcend it—to describe a technology, analyze its strengths and weaknesses, and discuss its possible implications—a "case study" that essentially symbolizes what *Technology Review* is all about.—*S.J.M.*

Engineering the Ivory Tower

By definition, engineering is science applied to the needs of humanity. In our society, these needs are the joint responsibility of our governments and industries, the former kept efficient and in the public interest by the democratic process, the latter by the incentives of competition under free enterprise.

The universities' relationships with government have been forged in the years during and since World War II into what has become a national policy: the universities represent a resource so much in the public interest that government support is justified, indeed essential.

The transfer of technology between universities and the industrial sector is equally essential, but a basic format has been elusive. The problem arises, of course, in the fundamental difference between a university's dedication to knowledge for the public good and an industrial firm's commitment to its own corporate strength. The problem of government-sponsored classified research, which has been essentially resolved by the universities' decision to eschew it, has an analog in the proprietary concerns of industry. But proprietary concerns are so ubiquitous that a parallel decision to eschew all industrial research with proprietary implications is unthinkable.

In an earlier, more innocent, era, the problem seems to have had less force. M.I.T., for example, chose its present Cambridge location in part to be near the industrial strength of Massachusetts with which it intended to interact, and the generous consulting privileges given its faculty are surely one reason for its early and substantial influence on the development of U.S. industry.

But now, in a time of more sophisticated technology and social institutions, conflicts—potential and real—surround university-industry relationships. What of the faculty member who has to choose between a university's policy of free dissemination of research and the prosperity of a company in which he or she holds an equity position? What of a university administration in the same dilemma? What of a laboratory director who doubts the efficacy of research that seems to be in the interest of an industrial sector among whose advisers he or she sits? How much exclusivity should a corporate sponsor expect on the results of research for which it has paid but which was performed in an institution that owes its existence to public support?

These are complex issues, and it is easy to deal simplistically or even alarmingly with them. But the fact is that universities' relationships with industries are today the object of highly sophisticated policymaking that deals—usually successfully—with the many points of potential conflict and abuse. In a time when the nation urgently needs new technology and the economic strength that derives from it, greater confidence in and exploitation of this relationship between universities and industry that spurs ever greater technology transfer is clearly in everyone's interest.—*J.M.*

The Changing Masthead

A familiar name is withdrawn and a new name is added to the masthead.

The withdrawn name is that of June Kinoshita, formerly senior editor, who has temporarily turned from writing and editing to world traveling—enviable good fortune for her and bad fortune for the rest of us.

The new name is that of her successor, Thomas Burroughs, who has joined *Technology Review* after an eight-year association with the American Chemical Society following training as a science writer at Ohio State and the University of Wisconsin. For seven years prior to 1980, Mr. Burroughs was both writer and producer of the weekly ACS radio show, "Man and Molecules."

More recently, Mr. Burroughs has been manager of the ACS News Service, one of the most effective efforts by any professional scientific society to help media report the achievements and problems of the profession.



We rejoice that Mr. Burroughs' wide acquaintance with the scientific community, deep understanding of science and the issues that surround it, and good judgment and quick humor will now be at the service of *Technology Review* subscribers—who soon enough will learn how fortunate they are.—*J.M.*

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LETTERS

A Gratuitous Better Idea?

In "Basing the MX Missile: A Better Idea" (*May/June, p. 20*), authors Richard Garwin and Sidney Drell argue convincingly against the need for any new MX-type weapon, yet they insist on presenting their own system. To proceed with their system, which retains the inherent properties of the MX system they so ably debunk, they simply beg the question: "Thus the issue is not whether but *how* to respond to the growing threat."

Because the MX missile is designed to destroy silos, it is a first-strike weapon. While the proposed alternative can achieve "high accuracy comparable with the original MX," why would one want such a weapon? The list of vaguely plausible reasons is very short: we plan to start a nuclear war, we believe in the concept of "limited nuclear war," or we are seduced by the aura of "technical sweetness," zippy jargon, and power politics that envelopes military projects.

Perhaps the third motivation applies here, yet that kind of deliberate naiveté is a luxury that scientists can no longer afford. By giving our proxy to the military on important questions and then fencing with them on the technical aspects, the scientific community serves the public very poorly.
Peter D. Meyers
Berkeley, Calif.

Mr. Meyers is associated with the Lawrence Livermore Laboratory—Ed.

Our Minuteman missiles may be vulnerable in the near future, but only in a theoretical sense. A Soviet first strike against these missiles would involve enormous risks. Would their missiles work according to specification? Would the necessary high degree of accuracy be affected by flight near the North Magnetic Pole? Would the United States retaliate with its remaining nuclear weapons?
Paul Laub
Amherst, N.Y.

Authors Drell and Garwin respond:
The problems of counterforce capability and accuracy, and the overall need for any MX missile, are central to the profound issues of where we are going with arms control, deterrence, and the hope for survival in today's nuclear world. We hope such issues will remain at the core of the debate on our nuclear-weapons policy. We tried to address only one aspect of that question in our article: assuming that the MX missile will be built, how should it be deployed? Our proposed system is cheaper, more flexible, more survivable, and a better precedent for deployment of a strategic force than the system chosen by the air force and the Department of Defense under the Carter administration. Whether one wants to buy *any* system of that nature is another question entirely.

The thought of a hundred slow, diesel-propelled submarines popping up and down in our coastal sea lanes is enough to give an old submariner nightmares. I am afraid the authors of the scheme have never served in a small submarine on the surface in a rough sea, or seen what waves can do to a solid structure, let alone detachable pods and rubberized fabric fairing. The navy has trouble enough keeping its submarine crews from becoming inattentive on long, boring patrols; staffing defenseless and uncomfortable little missile boats would be even less attractive.

Finally, any submarine, big or small, requires meticulous attention to quality in every detail of construction, material, and personnel. The average shipyard using commercial procedures is incapable of building safe submarines, and the only yards that currently have a submarine capability are overloaded with building combat submarines. The SUM concept is imaginative, but I am afraid it is not a very good idea.
John Alden
Pleasantville, N.Y.

Languages of Labor

"A Labor View of Technological Innovation" by William W. Winpisinger (*April, p. 10*) is a real contribution to our understanding of what is wrong with the United States. I am sure he will agree that the "corporate state" is also the "military industrial complex" which has taken over the Reagan administration.
Karl A. Grossenbacher
El Cerrito, Calif.

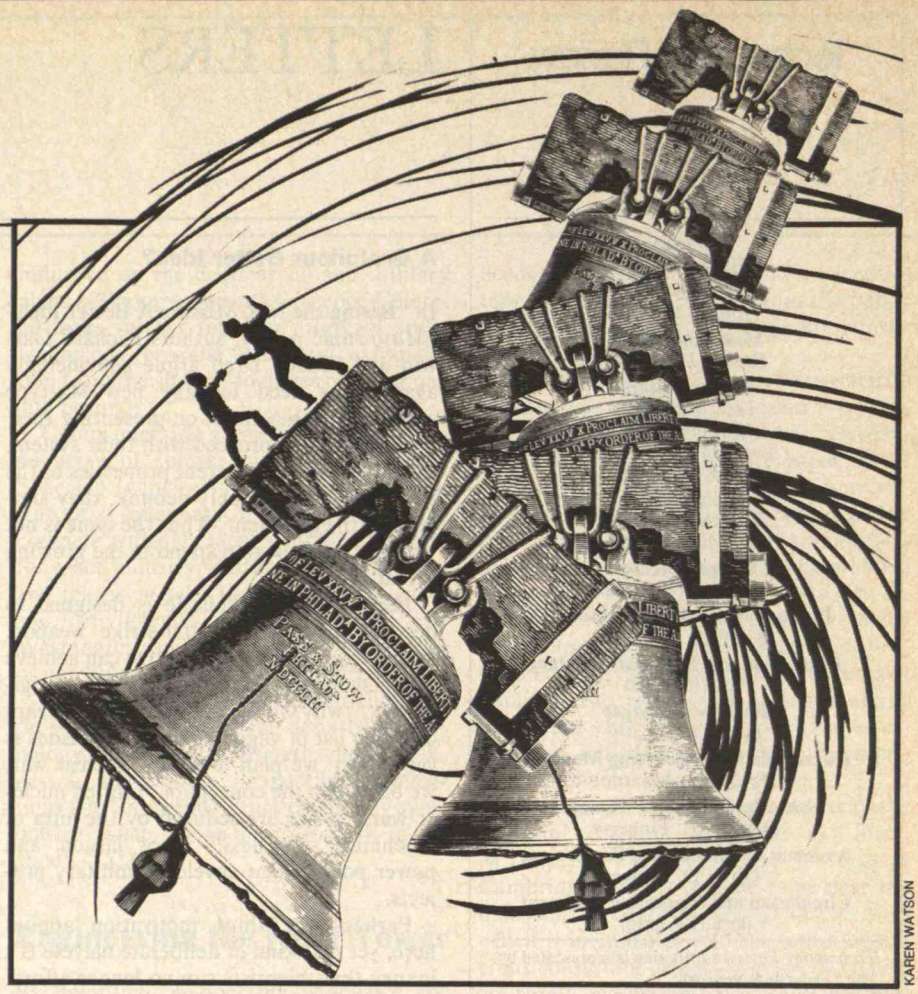
William Winpisinger's point of view reflects a tragic aspect of our industrial scene—the adversarial position taken by labor against management.

While I and many other chief executive officers understand the need for the labor-union movement, its most tragic weakness is that union members support but do not actively participate in their union. It is left to the Winpisingers of the country to make
(Continued on p. 15)

Kenneth Boulding



The Echo Stops Here



KAREN WATSON

PERHAPS the most striking property of both biological and social systems is that they are "echo" systems. We shout "ha!" and it echoes and re-echoes "ha-ha-ha, ha-ha-ha!" until it finally dies away—that is, if the system has equilibrium. Although echoes in the world of sound leave little if any trace, echoes in biological and social systems often transform the original structure.

Ecosystems are "echo" systems mainly because change in one population affects others. Systems in the physical sciences rarely exhibit echo effects and are therefore very poor analogs for biological and social systems. The physical sciences may be successful, especially in prediction, because they deal with fairly isolated equilibrium systems. The solar system is a good case in point: the extraordinary success of celestial mechanics is a result of the fact that the solar system has virtually reached an equilibrium, apart from some minor human disturbances.

Causes and Multiple Effects

However, in biological and social systems, especially evolutionary systems, echo effects are rampant. Indeed, we have done a great deal of harm to the biological and social sciences by trying to find the patterns of the physical sciences within them. This is not to deny the possibility that physical analogies may have a certain short-term value, such as in econometrics, but such analogies are always dangerous because of the difficulty of accounting for unexpected change.

Thus, we must beware of any simple concepts of cause and effect. We are always running into multiple causes producing multiple effects, and the effects of a single event are often very difficult to trace. A good example is the extraordinary difficulty of tracing the impact of particular acts—legislative or even simple grants and taxes—upon the overall distribution of income or economic welfare. A gives something to B, but A does not give something to C. This changes C's behavior toward D, E, F, and so on, and the transfer changes B's behavior toward G, H, I, J, and K. These in turn change their behavior toward L, M, N, O, and P. A single act may echo and re-echo around the system until the ultimate consequences are very hard to gauge and also may be very different from the original act.

For example, a single act of Congress such as the Morrill Act of 1862, which set up the land-grant colleges, is still reverberating and has produced enormous changes. The tobacco quota of 1934 still produces large differentials in the value of farms in tobacco-growing regions, depending on whether they happened to be growing tobacco in 1934. There are a good many exceptions to "my law of political irony"—that whatever we do to try to help people hurts them, and whatever we do to try to hurt them helps them—but there are certainly enough examples supporting this law to be profoundly disturbing.

Will Reason Reign?

Of course, the more a system exhibits equilibrium, the less impact echo effects will have. However, we cannot rule out the possibility that the echoes do not die away but instead gather force until something shatters. A casual judicial decision by Pontius Pilate, one he may not even have remembered in later life, created a system of echoes that amplified for 2,000 years and produced enormous changes in human ideas, beliefs, artifacts, and behavior.

This world of symbols is as far from celestial mechanics as we can get and obeys no rules—some things reverberate and some do not. And unfortunately, there is no guarantee that the symbolic systems that reverberate and intensify are beneficial to the human race. All too frequently, folly and illusion reverberate even more widely and loudly than common sense and reason. Nevertheless, I believe that a real world exists independent of our images and ideas and is a profound equilibrating force. And while reverberatory systems may cause crashes—like the soprano's high C that smashes a wine glass—echoes usually die if the initial shout has been an untruth, even though the process may leave some horrifying debris in its wake.

I am convinced that some of the greatest errors in political judgment arise from our failure to recognize the echoing nature of the social system. A good example is the present arms race, which is being entered into with the hope that it will bring security but which, because of its echo effects, is all too likely to lead us into destruction. Unless decision makers and the general public can see beyond the immediate consequences of this increase in armaments, the outlook for the human race is very dim.

To judge from my correspondence, I have made some people quite angry with *(Continued on page 14)*

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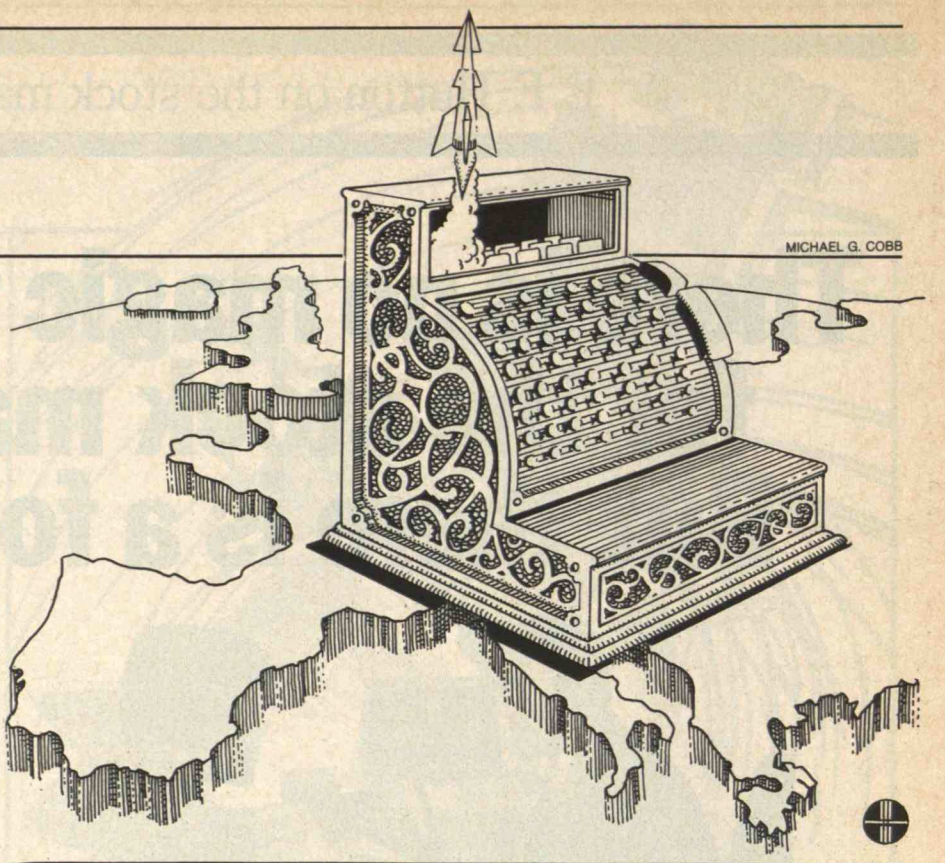
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Europe's Launch into Space Business

"ARIANESPACE—first commercial operational space carrier." So boasted last summer's advertisement by the marketing organization for Europe's Ariane, a rocket that had yet to complete its flight tests. But despite its premature nature, the announcement illustrates an important point: as commercial opportunities in space mature, the competition will not be left to the superpowers.

That is why champagne flowed at the Paris headquarters of the European Space Agency (ESA), and at its launch facility at Kourou in French Guiana, when Ariane passed its third flight test—*Ariane L03*—on June 19.

Analysis of the test data confirmed that engineers have corrected the first-stage engine instabilities and other engineering problems discovered after the second test last May. If the fourth and final test flight this fall is also successful, Ariane will be the first of what could become a family of increasingly powerful launchers that can challenge the United States and Russia for the burgeoning business of lofting other people's satellites into space.

"This means that space is no longer the exclusive preserve of a few powerful nations," says the director of ESA's Space and Transport Systems, Michael Bignier. The payload carried by *Ariane L03* underscores the point. In addition to a data capsule for the flight test, there was *Meteorsat 2*, Europe's geostationary weather satellite, and India's experimental communications satellite *APPLE*. Both were put into a transfer orbit, from which they later maneuvered by their own thrusters into so-called geostationary orbit 36,000 kilometers high. Here their orbital speed matches the earth's rotation so that they remain over a given spot on the surface below.

Competing for Space Launches

For the first time, Europe was able to put a major satellite into this desirable orbit without having to depend on the good will of a superpower. And India, eager to have a similar freedom for its own small but growing space program, was a willing partner.

The American Institute of Astronautics and Aeronautics has projected a 10-fold to 30-fold increase in communications satellite traffic between now and the year 2000. Thus, there will be enormous demand for launch vehicles for communications satellites, to say nothing of miscellaneous earth-observing, materials-processing, and scientific satellites. The relatively low cost of launching such satellites with the shuttle has "created such a demand the shuttle can't handle it," says Joseph B. Mahon, director of expendable launch vehicles for the National Aeronautics and Space Administration (NASA).

Ariane does offer an alternative until the shuttle, not yet operational, completes its flight tests, and Arianespace is certainly well placed to pick up some of the expendable launcher business. With prices competitive with or even lower than those of NASA, and with the prospect of increased performance with later Ariane models, Arianespace can make an attractive sales pitch. Grumman Corp., U.S. agent for the European company, estimates that Arianespace could get 60 of the 240 commercial payloads expected to be launched between 1986 and 1990, amounting to $1.4 billion worth of business (in June 1980 dollars).

Actually Arianespace, a private company with shareholders that include 36 companies and 11 banks in various ESA member countries, won't take full responsibility for Ariane until 1983—earlier launches will still be carried out by ESA. There are already 13 orders for launches and 14 other contracts under negotiation.

Ariane itself is what ESA calls a "very conventional and mundane" vehicle—well-designed using tried-and-true technology at an estimated cost in excess of $1 billion, well within expectations. What gives Ariane an unusual edge is the Kourou launch site. The open sea to the north and east makes for easy launching into either polar or equatorial orbits or orbits in between. Being only 5.5 degrees north of the equator, the location also allows Ariane to put 17 percent more payload into the geostationary transfer orbit than comparable rockets at higher latitudes. This is because the launcher doesn't have to make a "dog-leg" to maneuver into equatorial position. There is another slight launching gain in starting out with a greater eastward velocity owing to the earth's greater speed of rotation at lower latitudes.

An Ariane Family

ESA is already planning to build a second launch pad at Kourou in anticipation of more business. This would allow for overlapping launches and permit an increase from the five per year now planned to at least ten per year. From this and the proposed improvements to the Ariane launcher itself, it is obvious that ESA and Arianespace partners are determined to become a major factor in space. As Arianespace chairman and managing director Frederic d'Allest explains, "I don't consider the Ariane an interim concept. I think that in the long term—at least the next 20 years—we shall be able to offer an Ariane family with progressive improvements and we will have an excellent launcher product line."

That product line may well include both *Ariane 2* and *3*, already approved for devel-

(Continued on page 14)

Beyond headlines.



with correspondent
Charlayne Hunter-Gault

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Nuclear Power and the Reporter's Plight

by Mark Bowden

EVEN in a perfectly reasonable world, one populated exclusively by careful and intelligent people, society might be stumped by some of the questions that attend nuclear reactors.

Take the lively debate over the effects of exposure to low levels of radioactivity, for example. There are almost no significant data on which to base a judgment. There are some records gathered from survivors of atomic blasts over Hiroshima and Nagasaki. There are some studies of patients who years ago received x-ray treatments at exposure levels now considered excessive. If you plot these data on a graph that compares dose levels with the number of cancers that develop among the exposed group, you end up with a cluster of points showing cancer cases among those exposed to high doses but with only a few scattered points in the lower dose range. Where you would look for evidence of how those exposed to low levels of radioactivity fared over 20 to 30 years, you would find mostly white space—a blank, staring question mark.

Radiating Knowledge

Experts such as Dr. Edward P. Radford at the University of Pittsburgh, who served as chairman of the subcommittee that three times studied this question for the National Academy of Sciences, and physicist Harald H. Rossi at Columbia University, who served on the subcommittee all three times, both scientists of widely acknowledged integrity and expertise, draw radically different shapes to connect the scattered points in the white space of that graph. Radford sees a distribution of points that arrays itself roughly along a 45-degree angle. That line, known as the linear-dose model, affords a straightforward interpretation: for every increased dose of radiation there will be a proportional rise in cancer among the exposed groups.

With equal confidence, Rossi draws a curved line through the points. His curve slopes sharply upward in the outer range of the graph, showing the documented increases in cancer among those who received higher doses of radiation. But at lower levels, Rossi's model shows virtually no increased incidence of cancer from exposure to low doses of radiation.

For all their respectability, Radford and Rossi have little more than contempt for each other's opinion. In the nine years they have battled, Radford's model has prevailed with the subcommittee all three times. However, last year a special panel of scientists appointed specifically to unravel the Radford-Rossi conflict adopted a compromise more like Rossi's curve than the linear-dose model. Although Radford and Rossi both reject this compromise—Radford calls it "sheer nonsense"—it currently is the basis for U.S. policy decisions concerning radiation and public health.



There you have it: choose an issue in the great nuclear debate, from the hazards of low-level radiation to nuclear-waste disposal to the safety of fission reactors, and if you can somehow thread your way through the maze of propaganda, social pressures, politics, pseudoscience, and superstition you will arrive at your own Radford-and-

What the Public Needs to Know

by Jennifer Trainer

TWO and a half years ago while I was an editor at Simon & Schuster, a proposal for a book about nuclear energy landed on my desk. Like most antinuclear books, this one promised to be overly emotional, aimed mainly at those who subscribe to a wood-burning-stove ethic. Pronuclear material was just as bad: dry, full of scientific jargon, and impenetrable to the average reader. Since the arguments from both sides often substitute rhetoric for reliable information, they do nothing to improve public understanding of the complex issues surrounding nuclear power.

The American people are suffering from a crisis of confidence: they no longer trust the experts and are confused by conflicting scientific reports. They want to believe that nuclear power is safe—they want to give the benefit of the doubt to the technology—but in an age where technological innocence was lost long ago, people are more critical of what's being done in the name of progress. They need the facts and opinions regarding nuclear power presented in a clear, logical manner.

The Media as Scapegoats

Many pronuclear scientists complain that the media are often more interested in entertainment than in responsible reporting. Frequently the smallest glitch or radioactive leak at a nuclear power plant makes the front page, whereas the fact that 50,000 deaths result yearly from exposure to coal-fired pollution barely penetrates the American consciousness. But to suggest that the media are responsible for the nuclear controversy would be avoiding the issue. Scientists—not the media—are ultimately responsible for seeing that the facts are presented accurately and clearly. Unfortunately, some of the most distinguished scientists on both sides of the debate have sometimes done themselves a disservice in their attempts to reach the public.

For example, when a respected antinuclear scientist told me that a pound of plutonium—perhaps the size of an orange—could kill every person on earth, my first response was fear; it certainly is a sobering thought. But my second response was to wonder how plutonium could be distributed in that manner—one would have to be extremely clever to stretch a pound worldwide. And although I was impressed with the toxicity of plutonium, I was not convinced that it or the breeder reactor should be outlawed on that basis alone.

Similarly, simplistic pronuclear statements fail to make the best case. I remember a well-known pronuclear scientist stating that we're exposed to more radiation in



JAMIE HOGAN

Rossi type of situation. Faced with a dilemma like this, reporters assigned to write about nuclear power can ultimately do one of two things. They can choose a side, adopting either the romantic but ill-paid role of antinuke crusader or the uncomfortable but amply rewarded role of an industry spokesperson. Or they can painstakingly present both sides of the issue again and again, gradually infecting readers with their own confusion and ambivalence, doomed to be forever eyed warily by utility flack and activist alike, and condemned eternally to stand in dumb ferment every time a relative or friend asks, "Tell me, you've been covering this stuff now for more than a year, should I be for or against nuclear power?"

Earlier this year, shoulder to shoulder in a lunchtime crowd at a restaurant in Washington, D.C., Victor Gilinsky, then the head of the Nuclear Regulatory Commission, pondered his own dilemma, which is in many ways like a reporter's.

"You know, people don't ask if you're pro-oil or pro-coal," he said, speaking in his slow, deliberate fashion, frowning and peering over his glasses. "Nuclear power has this *religious* aspect to it; advocates and opponents approach it with this blanket fervor, with no gray shades at all."

An expert like Gilinsky, who specialized in scientific and technical problem solving for the Rand Corp. before being appointed to the commission by President Ford, can rely on his own experience to sort through the cacophony of opinions. But a reporter recently yanked off suburban coverage and handed responsibility for writing about the Three Mile Island nuclear power plant, where the full panoply of nuclear problems is focused intensely, can find seeking even simple answers dangerous.

Outmaneuvered

On my first trip out to TMI early last year I interviewed Bob Arnold, a vice-president of Metropolitan Edison Co., co-owner and operator of the plant. Arnold is a slight, silver-haired nuclear engineer with a nagging cough. He is supervising the company's efforts to decontaminate TMI Unit 2, the reactor that was badly damaged during the accident in 1979.

Knowing almost nothing about the accident, nuclear power plants, or nuclear issues in general, I had only simple questions to ask. It occurred to me that the purpose of every employee and device on the island was to safely contain whatever was locked inside the steel-walled reactor vessel of Unit 2. So I asked Arnold, "What's in there?" And he obligingly catalogued the contents, the partly crumbled fuel core and the radioactive fission byproducts bathed in a circulating borated water solution.

"How dangerous is it?" I asked.

"What do you mean?" answered Arnold.

So I tried to explain. Something at the center of all these protective layers of machinery and piping and shielding was presumably hazardous enough to warrant constant, elaborate, and expensive containment. So how potentially dangerous was the stuff? *(Continued on next page)*

our living rooms than from nuclear power plants. He went on to explain that we are exposed to radiation from watching television, smoking cigarettes, living in brick houses—and even drinking beer. Although what he said was accurate, I was offended by the remark; not only did it insult my intelligence but it unfairly played on my fears as well.

I knew what he was trying to say: that routine plant emissions expose us to negligible amounts of radiation; that nuclear power has received more attention than any other source of radiation; and that if we compare the various sources of exposure, we might realize that the risks from nuclear power plants are acceptable. However, he reduced the idea to such a simplistic remark that the complexity of the issue was obscured. Many Americans still think a nuclear reactor can explode like an atomic bomb, and here was a distinguished scientist trying to allay public fear of an awesome energy source by likening its impact to that of a television set. This is a bit like telling people a nuclear reactor is just a sophisticated pot for boiling water.

Scientific information need not be spoon-fed to the public. Those curious enough to formulate an opinion about nuclear power are intelligent enough to understand most facts presented clearly. Well, a pronuclear scientist might say, if we do not tell people about radiation from bricks and cigarettes and living in Denver, then how do we reach people? Do we tell them about the deliberations of "blue-ribbon" committees and subcommittees trying to develop standards and recommendations, surely a topic as dry and full of jargon as one can get?

Honesty Is the Best Policy

It is not enough to say that many experts conclude that the general public faces no danger from routine nuclear power plant emissions, or conversely that our children and grandchildren can suffer gross deformities from the cumulative effects of radiation; people have heard it before and no longer believe it. They don't want to be told the "truth" anymore; they want explanations. Scientists must instead tell people what they as experts think and why: why do pronuclear scientists believe that current exposure limits afford adequate protection to atomic workers? Why do antinuclear scientists believe that they don't? What kinds of studies have been performed? On what basis are nuclear safety studies accepted by some scientists and refuted by others? People do not necessarily want a lesson in radiobiology or nuclear physics; they just want to know that the scientist's judgment is sound and that their health is foremost in the scientist's mind.

Scientists must be candid. The many low-level radiation studies, which often yield conflicting results, underline an important feature of the nuclear issue: scien-

Continued on next page

Arnold explained, softly but sternly, that with the chain reaction under control and all the layers of protection surrounding the core, there was effectively no chance that the radioactive substances inside Unit 2 could accidentally escape. So, he reasoned, *there was no danger.*

One last try. Yes, yes, Mr. Arnold, granted that its chances for escape are nil, but, speaking hypothetically now, in order to understand the reason for all the fuss, how dangerously radioactive is the core? What would be the consequences if it suddenly, impossibly plopped down unprotected in the island parking lot?

Arnold, patiently now: "Don't you understand? It couldn't happen. Of what use is speculating about something that can't happen?"

At this point a reporter's brain screams—I gave up with Arnold. The next day I phoned Henry Kendall, a physics professor at M.I.T. and chairman of the Union of Concerned Scientists, a well-known group critical of the nuclear industry. Kendall was glad to oblige. He said there were an estimated 400 million curies locked inside Unit 2, an accumulated mass of radioactivity about 2,000 times greater than that released over Hiroshima by the atom bomb.

Several days after the story was published I happened to talk with Arnold again on the telephone. He objected to one thing in the article, he said. He didn't think it was fair or appropriate to describe the radioactivity in Unit 2's core by comparing it to a nuclear explosion.

Both were right, of course. Kendall accurately calculated and compared the intensity of radioactivity, and Arnold was correct in arguing that the comparison with Hiroshima was needlessly lurid and inflammatory. They had me outmaneuvered. The core was and was not dangerous at the same time. This curiously dichotomous truth prevails in all facets of the nuclear debate.

Shades of Black and White

As another example, here are two quotes on the disposal of radioactive nuclear wastes:

"The unique characteristics of commercial nuclear waste can be viewed as a blessing by environmentalists in several ways. It is one of the few wastes of our society that can be effectively controlled from an environmental standpoint and removed from the biosphere."

"There is not yet a demonstrated means for ensuring the safe, long-term isolation of these wastes. The programs set up by the federal government to identify and develop a means for managing and disposing of these wastes have been deeply flawed . . . The public has legitimate cause for concern."

The first quote is from the Edison Electric Institute, a decidedly pronuclear organization, in its publication *Nuclear Power: Answers to Your Questions*. The second is from a Union of Concerned Scientists report by Ronnie D. Lipschutz, entitled *Radioactive Waste: Politics, Technology, and Risk*.

Exposure to low levels of radiation is and is not harmful. Techniques for the safe, permanent disposal of radioactive wastes do and do not exist. Nuclear reactors are and are not safe. Pick your expert. Whom do you choose to believe?

Anyone who has ever watched a legislature in action knows that ignorance is at the heart of all true debate. Only when knowledge is absent are opinions strong enough to sustain intelligent contention. Whenever an obviously correct answer to any problem surfaces, real debate ends. Extremists may continue to argue, frequently at exhaustive length, but the answer sits patiently in wait. The extreme vehemence and polarization of the debates over nuclear power is the real cause for concern.

As a reporter constantly looking in both directions at once, inhabiting the real world of unopinionated nonexperts and Gilinsky's gray shades, I am left with the overwhelming impression that there are no obviously correct answers yet. New reactors are built, hazardous waste mounts. We've gone ahead with it anyway, answers or not.

There's a story in that, at the very least. □

Mark Bowden is a science writer for the Philadelphia Inquirer *and recipient of the 1981 AAAS-Westinghouse Science Writing Award.*

Trainer/Continued from page 9

tists do not know what the long-term effects of low-level radiation are. Extrapolations from Hiroshima-Nagasaki data and other high-level studies to determine the effects of low doses are still hypothetical. Scientists will never gain the public's confidence unless they say that "we can only be reasonably sure" when uncertainties are involved.

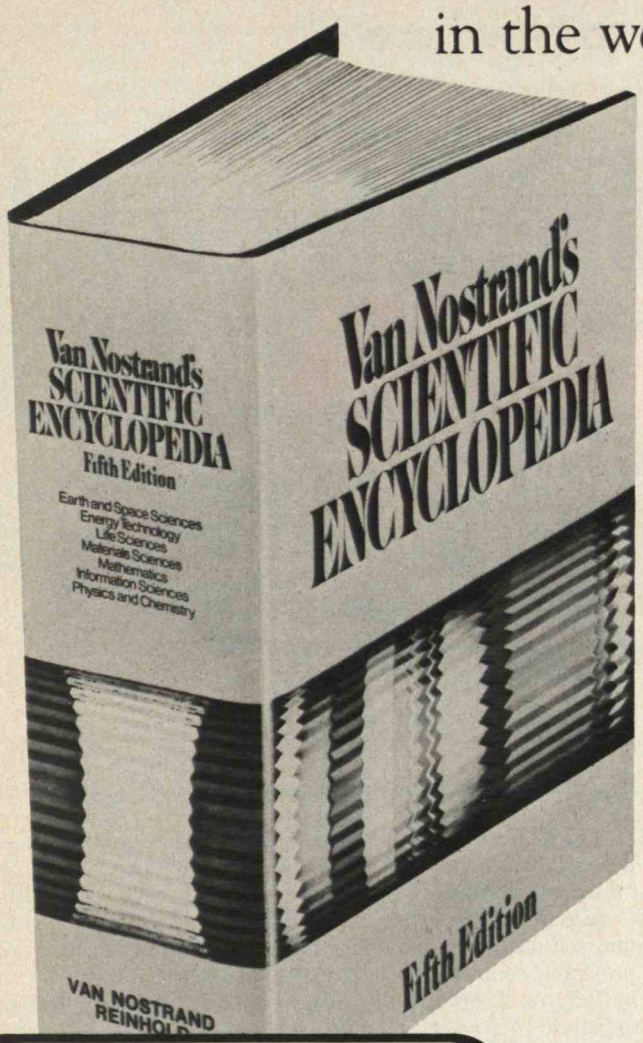
In one of the the most candid articles written on the safety of nuclear reactors, Dr. Anthony Nero of the University of California was very frank about the risks and dealt openly with the accidents at Brown's Ferry and Three Mile Island. He explained why he believed that nuclear plants are safe enough and gave readers room to formulate their own opinions. If he had stated flatly that reactors are safe and that the public must accept the judgment of informed experts who have the public interest at heart, and readers heard elsewhere about the accident at Brown's Ferry, chances are they would no longer trust what he had said.

There is a fine line between underestimating readers' intelligence and overestimating their interest. Basically, people want to know how nuclear power affects their lives; scientists will lose their audience if they talk about "The Genetic Effects of Neutrons in Mammals and Their Implications for Risk Assessment in Humans." People just want to know if radiation will harm them. It may not be enough to say that the risk at Three Mile Island was comparable to smoking a cigarette or driving a car for 10 minutes, or conversely, that tens of thousands of lives were endangered. Instead, scientists need to explain how much radioactive iodine was released, how it could get into humans, and what they believe will be the effects and why.

The debate over nuclear power is as much a political issue as it is technical or scientific. Nuclear power is not an absolute but rather a technology that must be continually evaluated. If people are given information accurately and comprehensively, they can decide for themselves. The first step to resolving the nuclear controversy is to bridge the gap between what the experts know and what the public needs to know. □

Jennifer Trainer's book on the nuclear controversy is scheduled to be published by W. W. Norton in the fall of 1982. Her coauthor is Dr. Michio Kaku.

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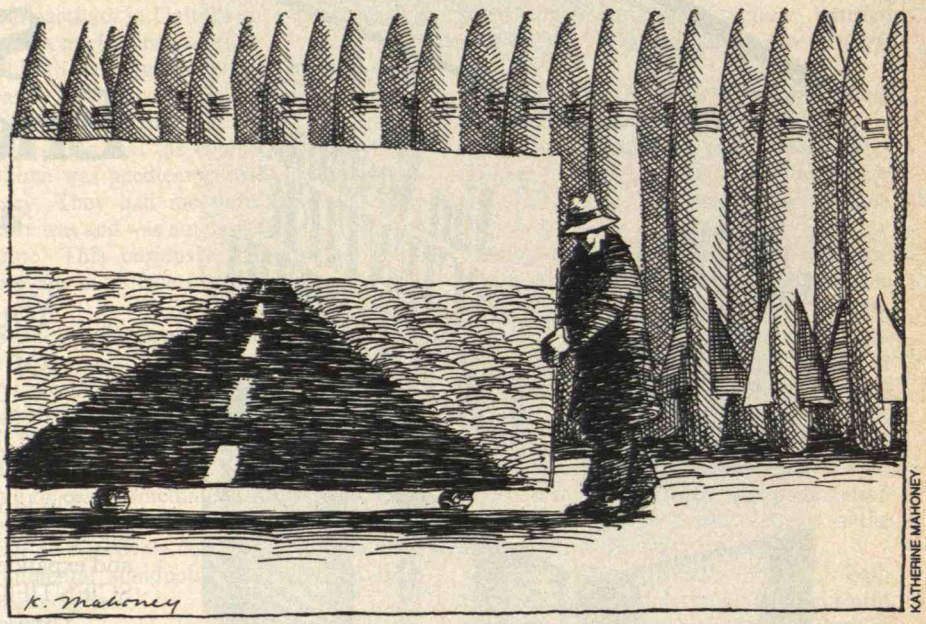
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Secrecy: The Road to Nowhere

by Edward Teller



KATHERINE MAHONEY

SCIENCE thrives on openness—researchers should, and often must, share their findings. But when Hitler's Germany began to pose serious threats, especially with its alleged atomic research program, governments around the world were obliged to put secrecy practices into effect.

While such secrecy probably helped assure Germany's failure to develop the atomic bomb, it was also instrumental in our decision to use the bomb without prior public demonstration. When the atomic age opened with a wartime bombing instead of a scientific display, the effects of secrecy unobtrusively entered our national life and began to alter its course.

After the war, the question of secrecy was reconsidered. Niels Bohr, the greatest physicist of the century, suggested: "In the cold war each side should use the weapon which it can handle best. Secrecy is the appropriate weapon for dictatorship, whereas openness is the weapon democracies should use." Bohr was dismissed as a crazy scientist when he carried this message to President Truman and Winston Churchill, who decided that only information that does not endanger national security should be published. The result was a proliferation of secrecy in science.

After many months of political inaction following Hiroshima, the United States presented the Baruch plan to the United Nations: the United States would share the secrets of nuclear energy in exchange for all nations agreeing to international control of nuclear power. The plan failed—the Soviets were not interested, not surprising considering that they had probably already guessed our atomic secrets. As I wrote in an atomic alphabet for my young son: "*S* stands for secret; you can keep it forever, provided there's no one abroad who is clever." But the practice of classification continued; this was our "security" whether it worked or failed.

In 1954, President Eisenhower proposed an international conference to explore the potential peaceful uses of atomic energy. Whether the Soviets participated or not, we would share the information—to do otherwise would have made little sense since scientific secrets do not keep.

We gave away a lot of information at the first Geneva Atoms for Peace Conference, and we accomplished a lot. Soviet scientists were delighted to present their achievements; clearly, the earlier refusal to participate in the conference was made by politicians, not scientists. With secrecy on reactor designs lifted, schools of nuclear engineering were established. Industries hired these engineers, and a dozen years later nuclear reactors competed with coal, oil, and gas in generating electricity.

The balance of benefit and loss in the first two decades of the nuclear "security" system seems clear: decisions made with inadequate preparation, self-deception, and diplomatic failure prompted deterioration of cooperation in the free world. Security regulations have also helped drive a wedge between our universities and our military research and development effort.

Secrecy Up, Productivity Down

Under present rules, research done in our national laboratories cannot be fully shared with those in civilian industries. When we fail to expose people to problems they could help solve, we remain unaware of the loss. We now have millions of classified technical documents; we also have falling productivity. Rapid progress cannot be reconciled with central control and secrecy. The limitations we impose on ourselves by restricting information are far greater than any advantage others could gain by copying our ideas.

In addition, by tainting science with secrecy, an unfortunate public attitude is perpetuated: science is nobody's business but the scientists'. Today science and technology are part of the life-support system of the world. Encouraging the development of a scientifically literate public is of primary importance to everyone's well-being.

Secrecy is not compatible with science, but it is even less compatible with democratic procedure. Two hundred years ago James Madison said, "A popular government without popular information, or the means of acquiring it, is but a prologue to a farce or a tragedy, or perhaps both." The term "credibility gap" is a modest description of our monstrous current problem. Of its many secrets, the government has controlled none more rigorously than information about the growth of Soviet weaponry and technical military expertise. But without such knowledge, the question of how much and what kind of defense our nation needs is left to the shifts of political winds.

Taking a Tip from Industry

How can we dismantle this expensive, gargantuan system of classification? First, we should identify those mattters that we quite properly should try to keep secret. We do not want press coverage of delicate diplomatic discussions or premature disclosure of government plans. For the last century, American industries have had *company-private information*, which allows dissemination of general knowledge but not the delivery of blueprints to one's competitors. It works because it restricts only the tricks of the trade—ideas that are hard to transfer except by detailed explanation. Information on basic issues remains free.

A similar system should be applied to research in national laboratories. I propose that a time be imposed on the classification of information as secret, top secret, special

(Continued on page 14)

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Teller/Continued from page 12

access, "burn before reading," or whatever. Technical advances pertinent to defense should be classified for no more than one year, and should then be shared with industry based on company-private procedures. Expert supervision could insure that the few cases in which longer-term secrecy is necessary are strictly limited.

A Policy of Openness

Although we have tried for years to achieve greater stability in international relations through arms-limitation agreements, the results have not been encouraging. However, the most important work today is on weapons of the future. As long as these arms are secret, they cannot even be discussed, much less limited. Adopting a policy of openness as the first and only unilateral step toward disarmament would strengthen our relationships with our allies as well as illustrate the advantages of freedom to our Soviet colleagues.

One of the earliest tales I remember from my childhood is about the adventures of a band of runaway puppets. They reached a fork in the road where one signpost pointed to "Nowhere," the other to "Everywhere." The puppets chose the latter, got into trouble, but in the end got safely home. I do not claim that openness will never lead to trouble. But I am sure that it offers us the best possibility of getting safely home. □

Edward Teller, physicist, is a senior research fellow at the Hoover Institution and a consultant at the Lawrence Livermore Laboratory.

Cowen/Continued from page 6

opment, and more ambitious versions studied and proposed by France. The present Ariane three-stage rocket is guaranteed to put 1,780 kilograms into the geosynchronous transfer orbit. *Ariane 2* and *3*, which should be available around 1984, are expected to boost that payload capacity and cut launch costs by as much as 25 percent. The improvements entail nothing dramatic—addition of two strap-on first stage boosters, improved thrust, more fuel capacity for upper stages, and the like. *Ariane 2*, which will not have the strap-on boosters, should orbit a little over 2,000 kilograms. *Ariane 3* is designed to to put more than 2,400 kilograms, or two-1,135 kilogram payloads, into the transfer orbit.

Ariane 4, which could be available by 1986 with four strap-ons, could cut the cost of orbiting a kilogram to 55 percent of that for *Ariane 1*. However, the most ambitious thinking—largely French—centers on the proposed *Ariane 5*, a two-stage launcher using the *Ariane 4* first stage with a newly designed liquid hydrogen/oxygen-fueled upper stage. It would put a 10,000 kilogram payload into low orbits about 200 kilometers high, or 5,500 kilograms into the transfer orbit, at 40 percent of current cost.

For *Ariane 5* French planners are looking beyond present types of satellites. They envision automated space factories for processing materials ferried back and forth by robot vehicles, and an automated space station with manipulators that could build structures in orbit. Indeed, this poses an important political question: ESA members must decide what they really want to do in space.

Only 10 of the 12 ESA members participate in the Ariane project: Belgium, Denmark, France, Germany, Italy, Netherlands, Spain, Sweden, Switzerland, and the United Kingdom; Ireland and Norway, which recently became associate members, do not. And of those 10, 3 account for nearly 89 percent of the funding—France (64 percent), Germany (20 percent), and Belgium (5 percent). Thus, ESA members hotly debate their priorities: Should they favor advanced communciations satellites as Britain has urged? Should they concentrate more on general space research, letting Arianespace make do with *Arianes 1, 2,* and *3*, as suggested by ESA director-general Eric Quistgaard?

ESA has yet to make up its collective mind or settle firmly on its future budget. But whatever its internal uncertainties, ESA is now a mature space agency that can carry its share of ambitious joint projects, cutting costs for both partners. Its success with Ariane challenges the United States to recognize Europe as a partner in the exploration and exploitation of space. Although there are precedents for this in previous joint ventures, that cooperation has been soured by unilateral cancellations and withdrawals by the U.S. that have more than once left Europe holding an expensive bag. □

Robert C. Cowen is science editor of the Christian Science Monitor *and former president of the National Association of Science Writers. He holds S.B. and S.M. degrees in meteorology from M.I.T.*

Boulding/Continued from page 4

my last two columns. But I am desperately afraid that we have turned what might have been an equilibrium system into a reverberatory system of echoing the Russians, who in turn echo us. I appeal to my readers to examine their own minds and hearts and to become aware of the frightening resonances that surround us. It is my hope that we might shout "peace" instead of "war." □

Kenneth E. Boulding is a program director of the Institute of Behavioral Sciences and distinguished professor emeritus of economics at the University of Colorado at Boulder.

LETTERS/continued from p. 3

all the decisions, and union members get the kind of "government" they deserve.

With respect to monopoly practices of large companies, I have found several of the larger companies (specifically Union Carbide and U.S. Steel) quite accommodating, and my companies were tiny compared with the competition. And Mr. Winpisinger's inference that there is a lack of ethics in the executive offices of big companies is simply baseless in over 90 percent of the cases.

William B. Klee
Hilton Head, S.C.

Mr. Klee is former president and chairman of Damascus Tube Co. and former vice-president of Copperweld Co. in charge of labor relations. Mr. Winpisinger responds:

It is ironic that Mr. Klee cites his experiences in the steel industry to refute my remarks. The basic steel industry is highly concentrated (two firms, Bethlehem and U.S. Steel, account for roughly 40 percent of total production) and is the quintessential example of the failure to innovate. Our steelmakers now turn to Japan for technological advice and marvel at its advanced innovations (including stringent pollution-control systems), many of which have not yet been implemented here. At the same time, most of our investment dollars are funneled into diversification and acquisition—not R&D or greater efficiency.

My views on the stultifying effects of corporate concentration are constantly reinforced by daily contact with members of the International Association of Machinists and all echelons of the American business community. However, I am at a loss to explain Mr. Klee's reading of an implication of business "lack of ethics" into my comments. I intended merely to discuss the broader consequences of our current direction of scientific inquiry and technological innovation, and of our present reliance on profit maximization by corporate giants.

Voting with Dollars

I vehemently object to the downright untruths told by Professor Thompson: Petroleum prices have increased threefold, not tenfold, in eight years (from about $.38 per gallon in 1973 to $1.23 today). Professor Thompson does not understand the difference between suppressing competition and actively pursuing competition. For example, we citizens make a positive decision as to where we buy our gasoline, be it from Exxon, Texaco, or Mobil. This kind of multiple choice shows real competition. There was no cheap Mideast oil, and no government-imposed import quota has ever existed.

Gail H. Swan
Dallas, Tex.

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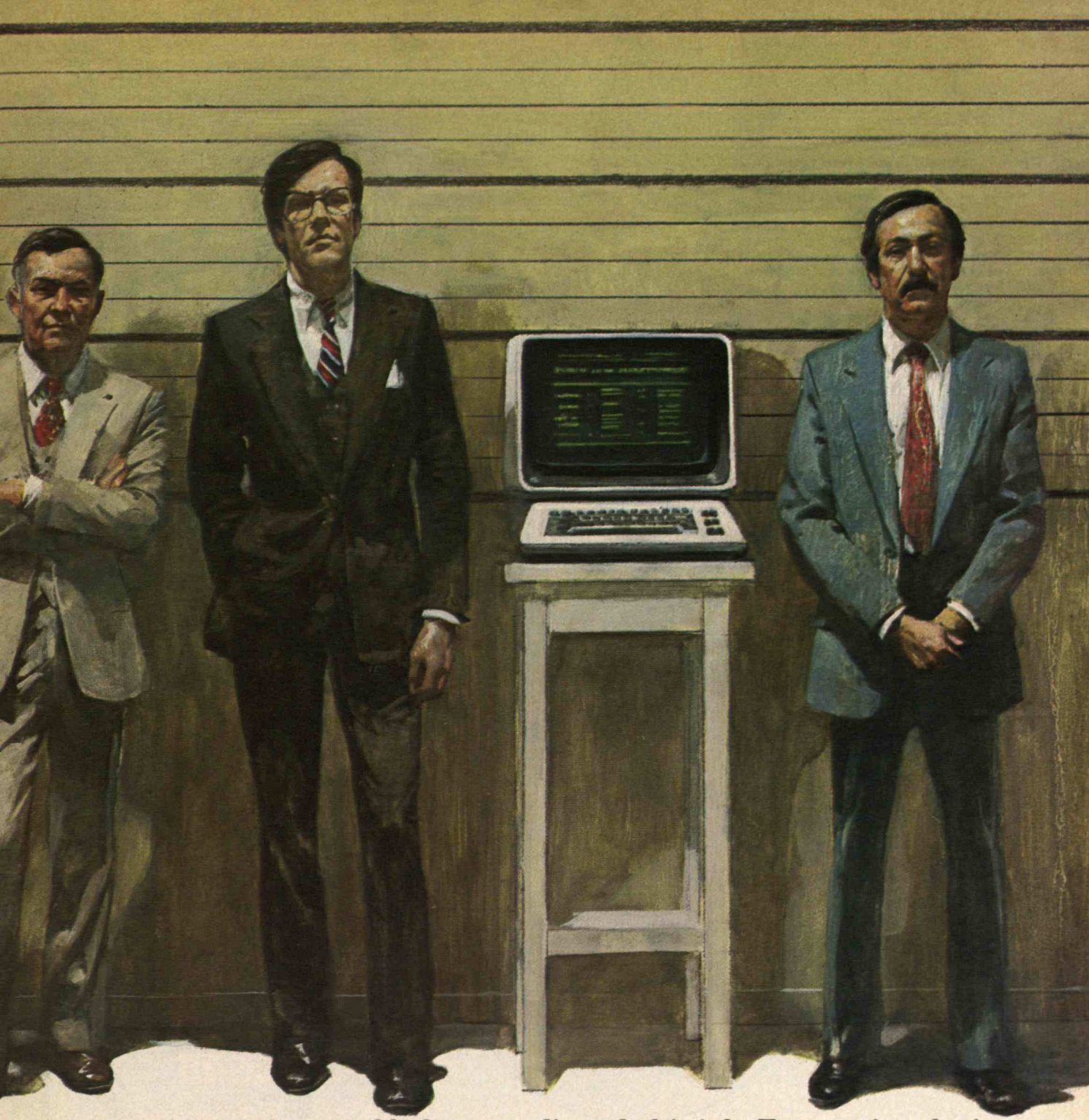
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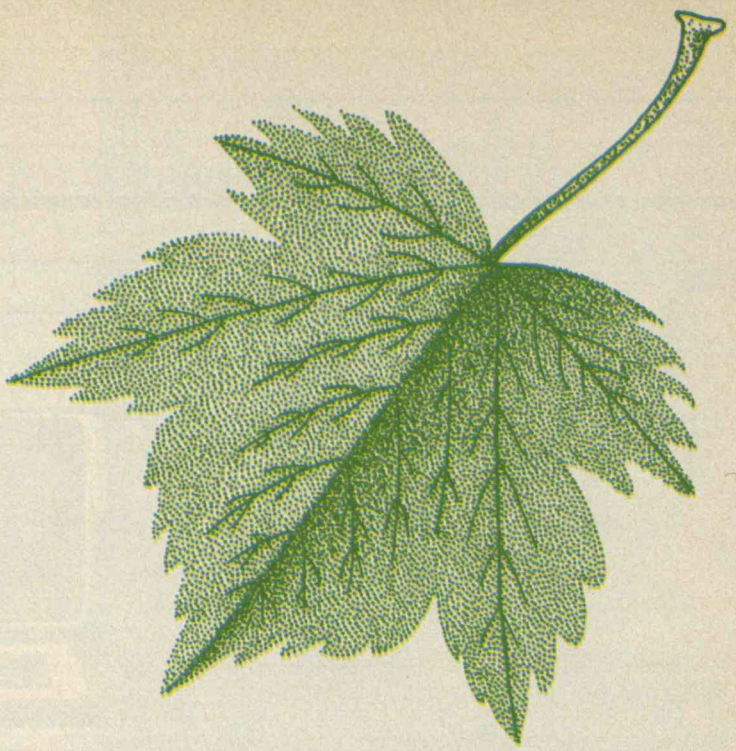
True, there's probably no such thing as total security. But with proper precautions, computers can be more than just safe places to keep information.

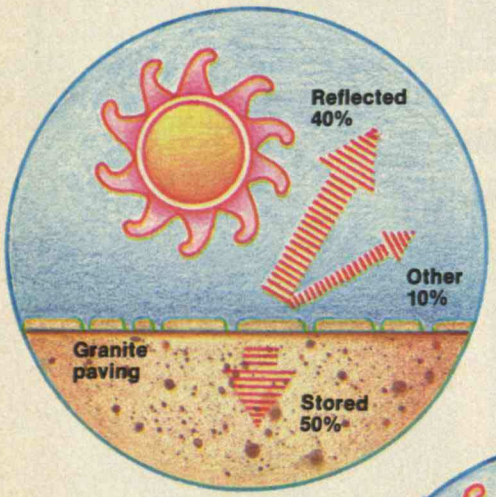
They may well be the safest.

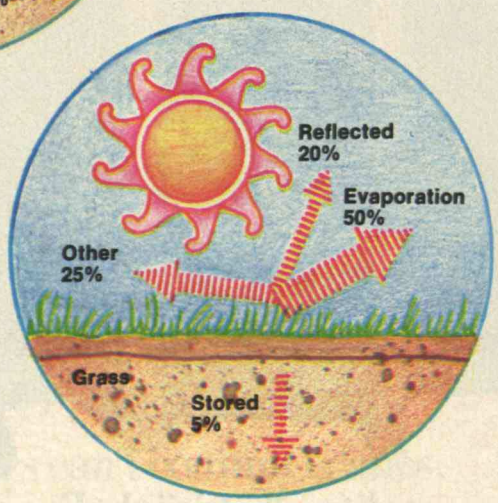
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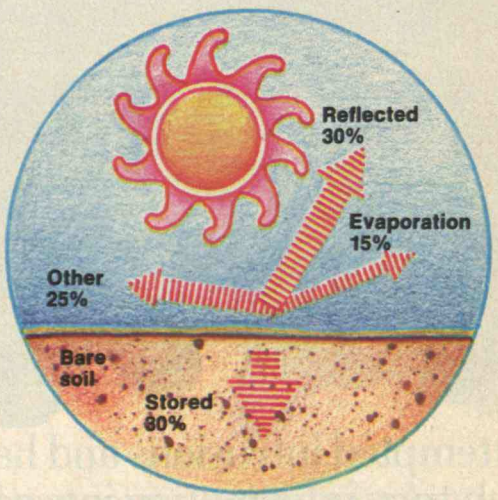
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The microclimate in your yard depends on the materials you use in landscaping. Because half the heat falling on granite paving is absorbed, it becomes hot. By contrast, half the heat falling on grass is used in evaporation and only 5 percent is absorbed—a cool surface. On bare soil, 30 percent is reflected, 30 percent is stored, and 15 percent is used in evaporation.









Landscaping to Save Energy

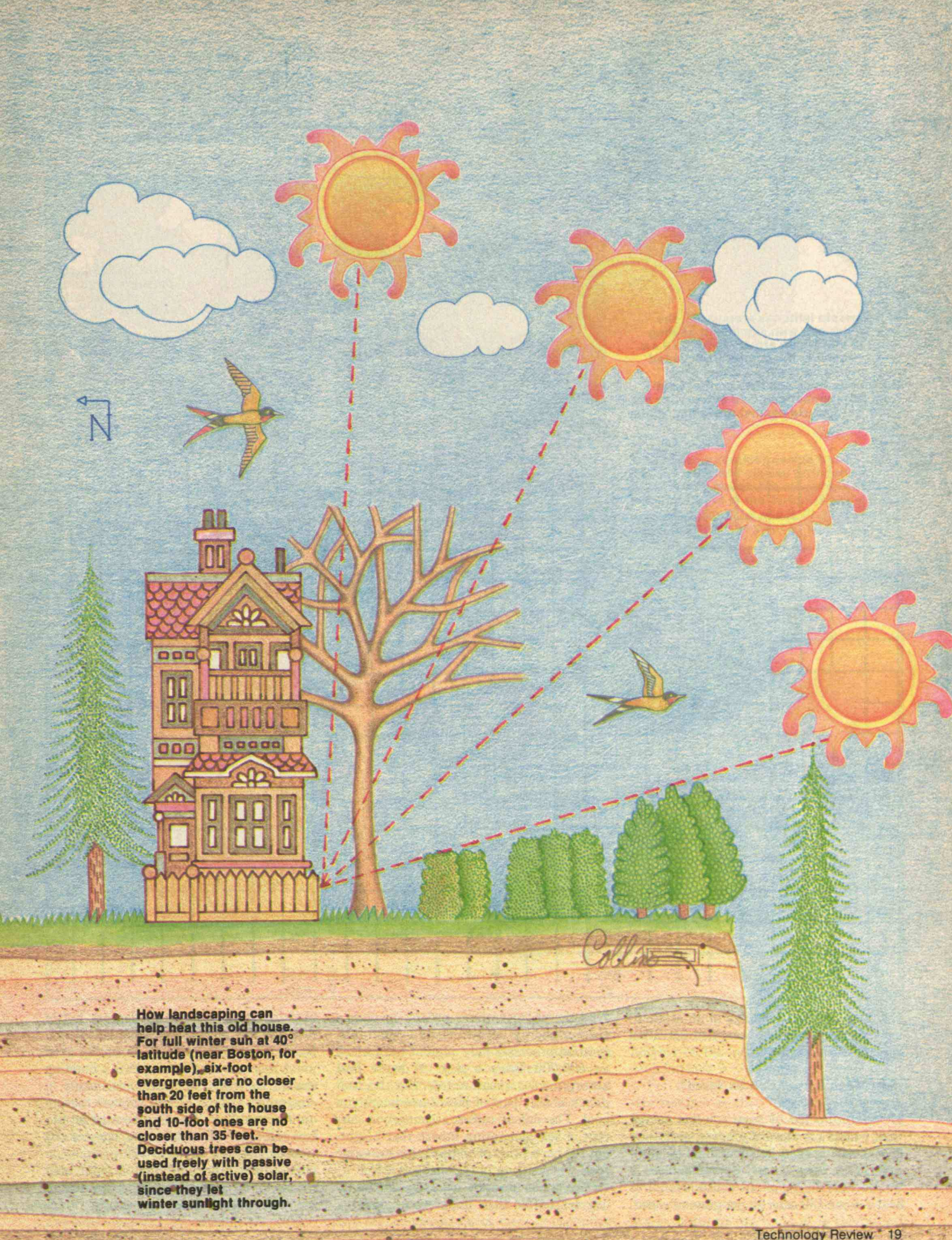
by Ruth S. Foster

ILLUSTRATIONS: DAN COLLINS

EVER since cavemen moved indoors and lit fires in the darkness, people have used their ingenuity to modify their surroundings to make life more comfortable. In the past, when cheap energy was available, the relationship between what we did with the land and how we used energy was of little concern. But as the price of energy rises, the idea that landscaping—on which we spend millions of dollars annually—could reduce our energy bills becomes of ever-greater interest. The potential is large: we now use 14 percent of our energy for space heating and cooling.

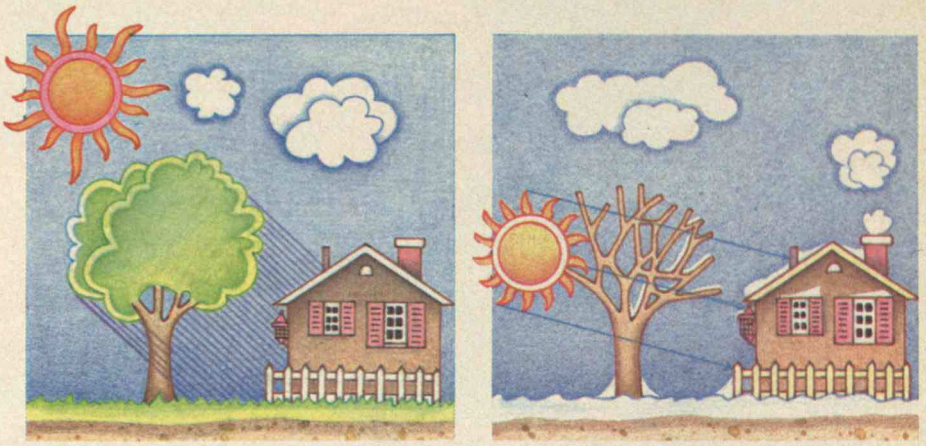
Consider modern cities. Unprotected concrete and blacktop act much as the desert sands of the Middle East. Lacking trees, shrubs, and grass, the desert absorbs sunlight and becomes unbearably hot. Because there is no green canopy, the heat can quickly radiate at sunset into the black night sky, and therefore deserts often become cold at night. In the same way, cities in the summer absorb the sun's heat, resulting in high energy consumption to keep the city cool. Unfortunately, pollution often impedes the radiation of this heat at night, and for this and other reaons cities do not cool off at night like the desert. In winter, concrete and blacktop absorb heat, but self-generated winds in the canyons between skyscrapers make streets and plazas uncomfortable and reduce energy efficiency.

Just as the desert can be made to bloom again, so our cities can be made more habitable. To combine landscaping, the art of

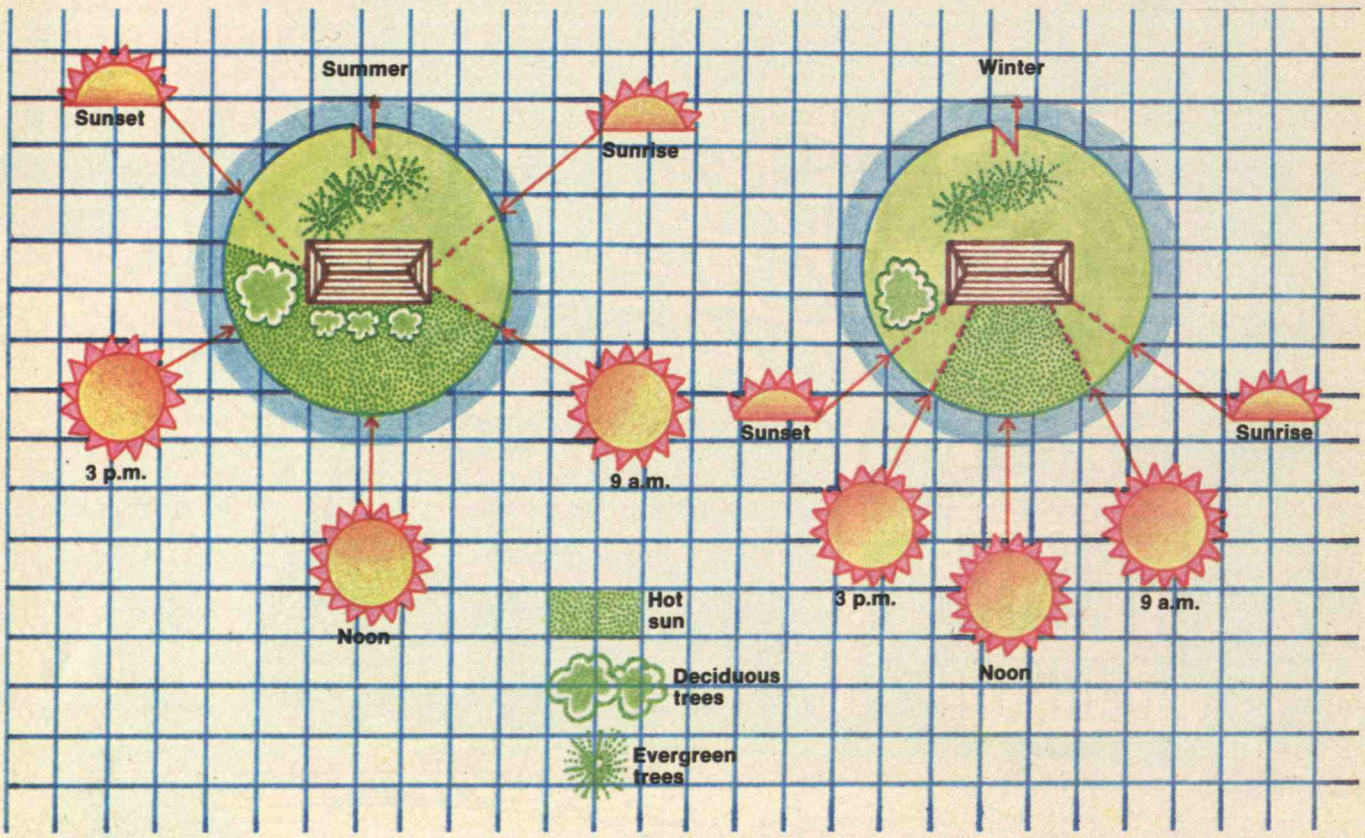


How landscaping can help heat this old house. For full winter sun at 40° latitude (near Boston, for example), six-foot evergreens are no closer than 20 feet from the south side of the house and 10-foot ones are no closer than 35 feet. Deciduous trees can be used freely with passive (instead of active) solar, since they let winter sunlight through.

Even with energy-efficient landscaping there is no free ride. A window shaded by a tree can be seven times cooler on a hot summer day (left) than one shaded by drapes, but the bare branches of the same tree will absorb about 25 percent of the solar radiation that would have reached the window in the winter (right).



In temperate latitudes around 40°, the only winter sun with significant heating value is that which arrives between 9 A.M. and 3 P.M. But in the summer, unwanted heat arrives between 9 A.M. and 5 P.M. Deciduous trees can help control heat from the summer sun, and evergreens are good windbreaks against prevailing winter wind.



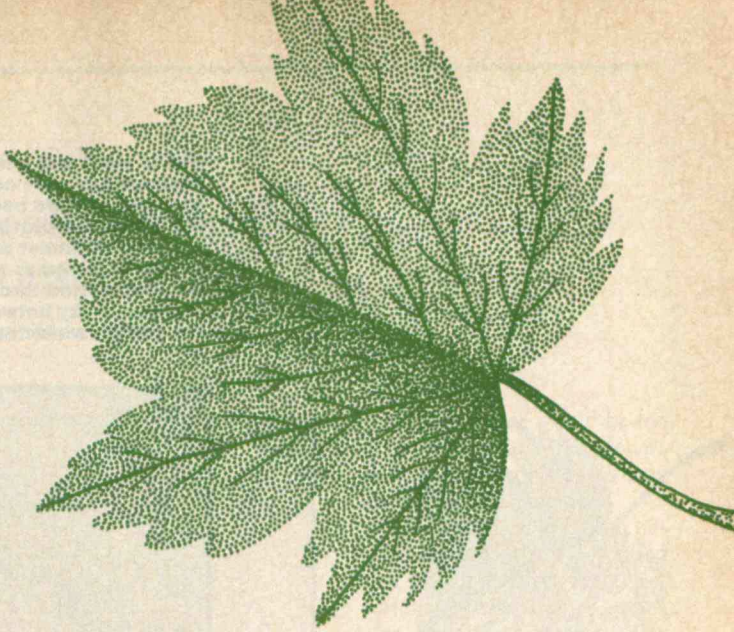
changing our surroundings in an aesthetically pleasing way, and energy conservation is a rewarding challenge.

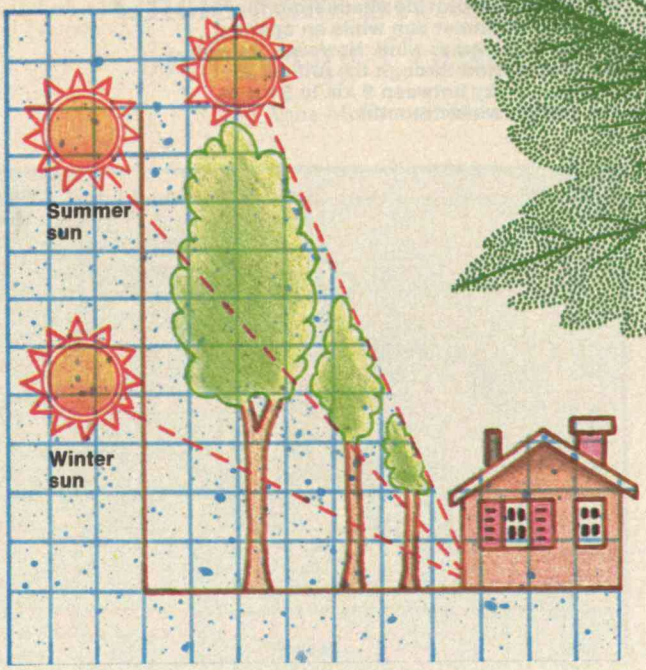
How Much Energy Can Be Saved?

Houses protected by trees use less energy than houses on exposed prairies, and these energy savings can be surprisingly significant. The evaporation of water from a tree's leaves during photosynthesis requires heat—some 580 calories per gram of water. And the photosynthesis process involves a further energy deficit. These evapo-transpiration processes may amount to as much as 600,000 Btu's a day of direct heat absorption for a mature tree. But this heat deficit is only part of how a tree keeps you cool. The deficit causes a convection current, a self-generating breeze that heightens the perception of comfort that everyone feels when sitting in the shade of a tree.

The air over sunlit blacktop can be 25 degrees hotter than under trees, and the blacktop itself will be 35 degrees hotter than the air. A building surrounded by a blacktop parking lot will obviously need much more air conditioning than a building shaded by leaves. Indeed, experiments in Australia's Gibson Desert showed that an unprotected "tin" building became an unbearable 116° F, while one covered by vines on a trellis stayed at 77° F.

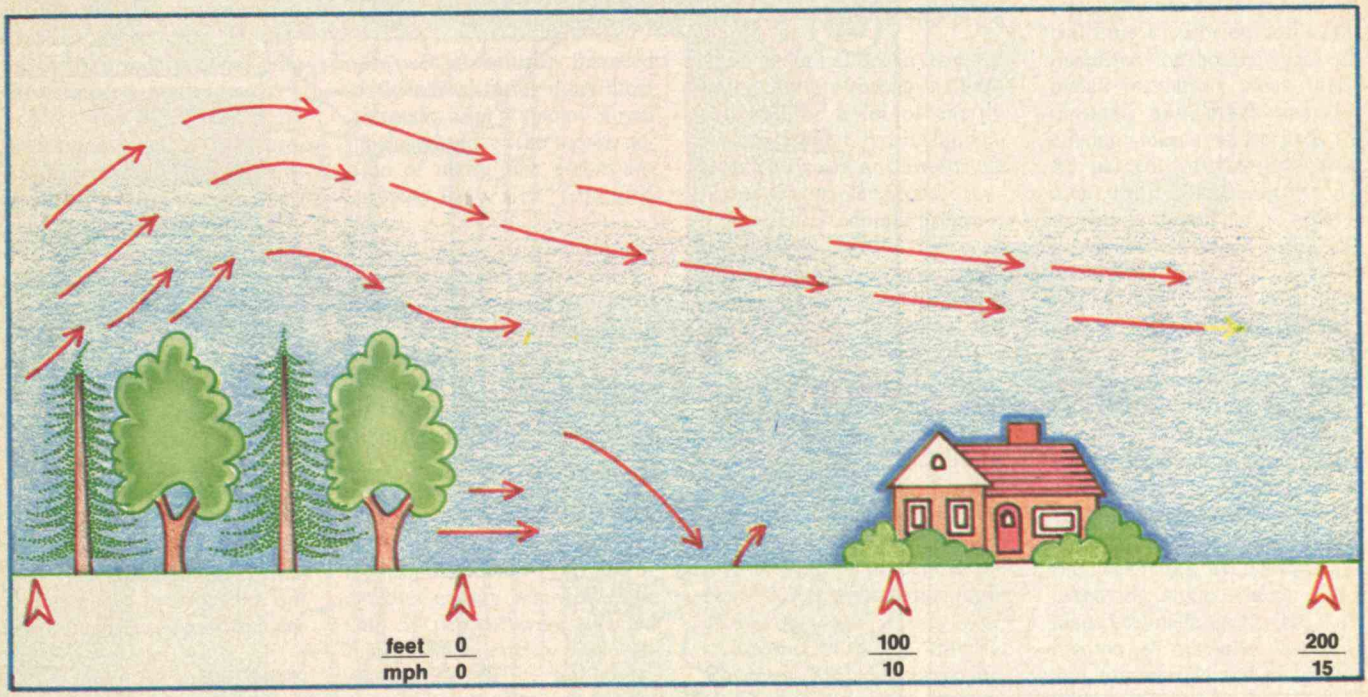
In winter, the chill factor from cold winds can be a major source of heat loss in buildings. Tests show that proper wind-





This drawing, with the angles adjusted to the latitude in which you live, shows how to minimize house heating from the sun in the summer and maximize it in the winter. In Boston, for example, a tree 25 feet from a building must be 40 feet tall to provide summer shade; a tree 10 feet from a building need be only half as tall. Lower branches should be pruned to elminate obstruction of the winter sun.

Trees offer a semipermeable barrier that lifts the wind and causes turbulence. In the example below, the air velocity 100 feet downwind of the 35-foot trees in a 35-mph wind would be about 10 mph; 200 feet downward the velocity would be 15 mph.



breaks can reduce wind velocity by 85 percent and lower heating costs from 23 to 40 percent.

These techniques are not new. Windbreaks were planted by settlers on the prairies and are still a common feature of climate control in the Midwest. (When fuel costs first rose in the 1970s, some farmers made the mistake of cutting their shelter belts for firewood. The extra heat required in a single winter without the trees equaled the heat obtained by burning the wood.) Yet today we continue to build many houses and most commercial structures and cities in energy-inefficient patterns. Indeed, scientific landscaping strategies are seldom applied systematically. When they are, fuel savings can be significant.

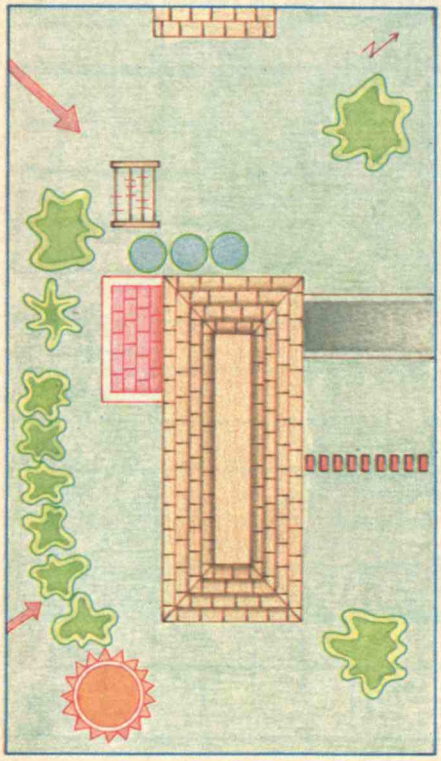
Seasonal Shading

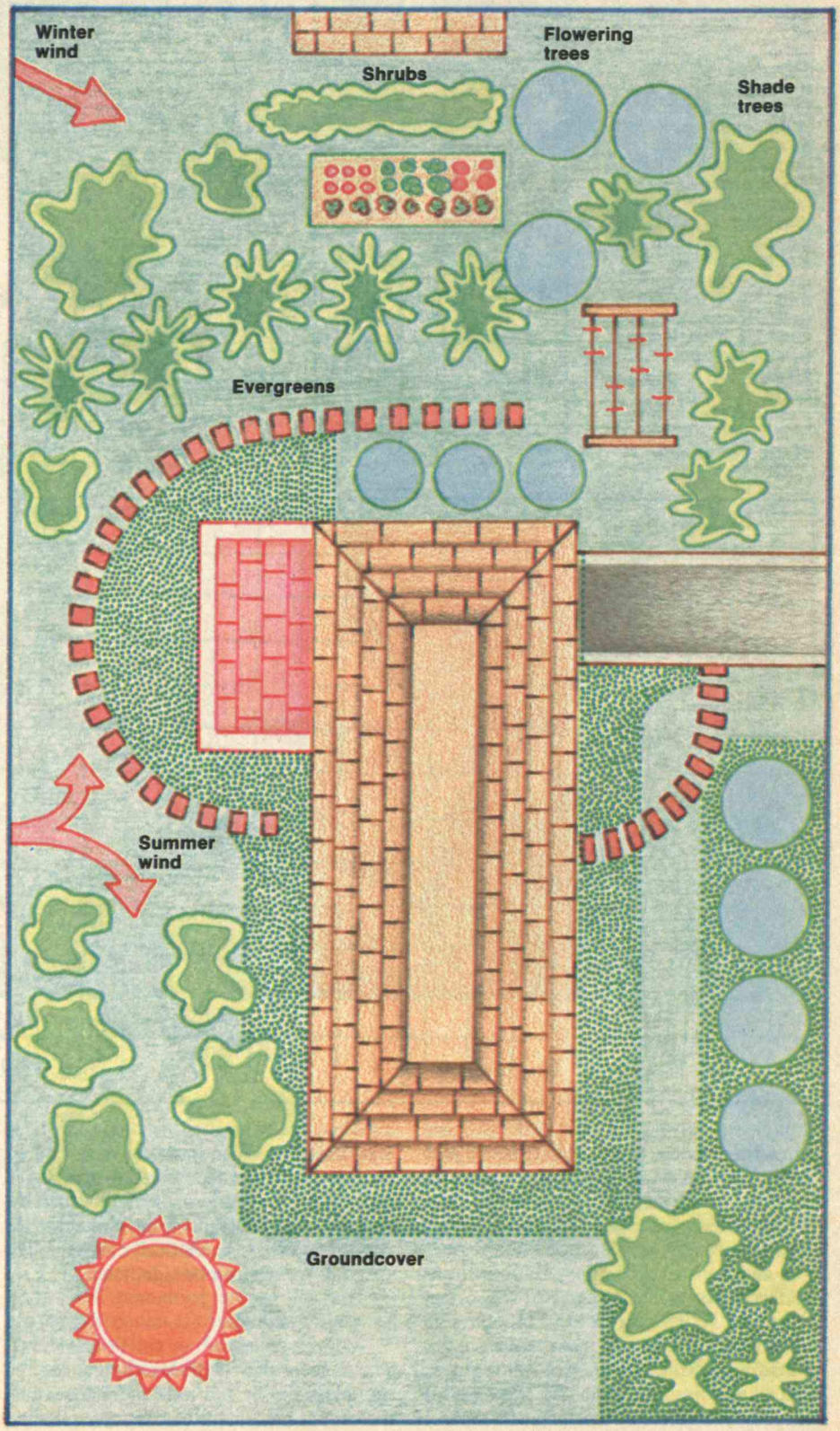
The concept of sun for heat and shade for cooling is simple and well understood. But the proper placement of trees to capitalize on the different risings, settings, and heights of the sun at each season and in each latitude is not simple.

For energy-saving purposes, the effective sunlight in the Northern Hemisphere comes only between 9 A.M. and 3 P.M. in winter and between 9 A.M. and 5 P.M. (daylight saving time) in summer. The rest of the time, the heat from the sun is essentially insignificant for energy conservation. This means that only a small section of the sky is useful for warming us in the coldest

Before (left) and after: changing the landscape to save energy. Extensive windbreaks have been added to the north, and trees now provide shade from the afternoon summer sun while an opening lets in the summer wind. However, the sun is unobstructed through the critical 25 degrees of sky between 9 A.M. to 3 P.M. in the coldest winter months.





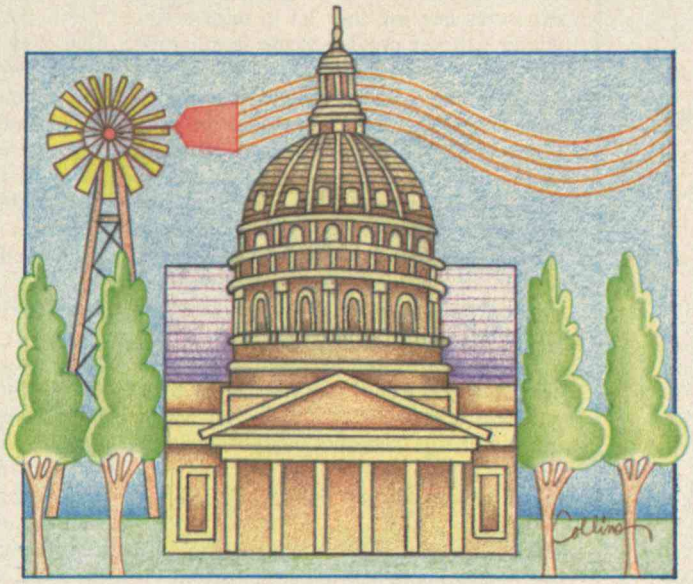


weather. In the Boston area, this critical area extends barely 25 degrees to the east and west of due south and ranges between only 15 and 35 degrees of elevation. This very small solar window is all that must be kept clear of trees and shrubs for winter heat. Many owners of solar installations who have made larger clearings have unnecessarily destroyed valuable plants and trees so they find that they have excessive summer sun.

Deciduous trees, which lose their leaves

Uncle Sam Breaks Ground on Energy Conservation

by Anne Moffat and Marc Shiler



WHILE our national research and development strategy is geared toward increased energy production, some aspects of the government's energy program encourage systems that reduce energy demand.

The establishment of federal building and energy performance standards (BEPS), which state the maximum amount of energy that may be used to heat, light, and cool buildings, could go a long way toward conserving energy. These building codes are descendants of the codes created in the 1970s by states and municipalities to enforce greater conservation. However, the new federal codes have three important advantages.

First, the BEPS codes are performance rather than prescriptive codes—they set standards for energy use for every new structure but don't require any particular combination of energy-saving techniques. Also, the techniques used to build the structure are left to the designer. In contrast, the old codes set specific guidelines for construction, including the percentage of glass allowed and minimum insulation values for walls and ceilings, but did not state the ultimate energy-saving goal. The establishment of performance codes presents the opportunity to use landscape design to save energy.

Second, the new BEPS codes will be more strictly enforced than earlier regional codes. States with energy codes usually rely on local governments, who in turn must depend on the astuteness and honesty of their building commissioners, and who have few penalites for miscreants.

If and when the new BEPS codes are finally established, all new structures financed with federal funds must meet the code. This is a point of real leverage since the construction of many new homes involves federally financed loans.

Finally, the BEPS codes are far stricter than earlier energy codes. They define the *total* maximum energy budget, in Btu's per square feet, that can be used to run a building, adjusted to the different climatic regions throughout the United States. These codes were developed after the federal government asked 168 architects across the country to redesign selected projects for greater energy efficiency. The top 50 percent were selected as models for energy conservation. The BEPS guidelines were established from these redesigns and pose a challenge to use all potential energy-saving strategies to meet the new stringent goals for conservation. Passive design techniques such as landscape planning and siting of buildings and windows should receive increased attention. A BEPS type of code will have only a small overall effect in its early years, simply because there will still be a lot of energy wasters around, but its longer-term (50 years and more) effect will be tremendous.

Another federal program involves tax credits for residential energy conservation. Passed by Congress in 1978, the program provides tax credits on 15 percent of the cost, up to $300, of installing insulation, caulking, and other conservation materials. For geothermal or wind-driven generators and solar heating systems, the tax credit is 30 percent of the first $2,000 invested and 20 percent of the next $8,000, up to a maximum of $2,200.

According to the Internal Revenue Service, taxpayers invested $139 million in conservation programs in the first 21 months of the program. In 1980 the tax credits for investments in renewable energy sources were increased from 22 to 40 percent of the first $10,000 invested. However, credits for passive conservation materials were not increased, on the grounds that such an increase would be too expensive in lost tax dollars and that homeowners already have sufficient incentive.

These credits, although admirable, are still too limited and stifle innovative design solutions to the energy crisis. For example, passive solar houses, which may use south-facing glass, insulation, heat-storing materials, and energy-efficient landscape design, are not eligible for existing tax credits. The credits should be based on how well a house performs, not on what kind of mechanical equipment it uses. The 15 percent credit for materials should be increased, to continue to provide sufficient incentive for homeowners to install insulation, clock thermostats, and other energy-efficient measures, perhaps to 50 percent of the improvement costs. Home energy conservation should be as highly subsidized as other forms of energy production.

The Solar Bank Act may may help fulfill this goal by providing immediate financing and subsidies of as much as $750 million through low-interest loans for renewable energy-producing equipment, and up to $3.35 billion in government-supported loans for conservation materials. Unlike the tax credits, available to all taxpaying homeowners, these loans are made on the basis of income to tenants, farmers, and commercial and nonprofit organizations. □

This article is from the book Landscape That Saves Energy *by Anne Simon Moffat and Marc Schiler.* *Copyright 1981 by Anne Simon Moffat and Marc Schiler and published by arrangement with William Morrow and Co.*

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Presents a colloquium entitled

MICROCAPSULES AND MICROCARRIERS IN BIOTECHNOLOGY

October 15, 1981
Kresge Auditorium, MIT
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Other Speakers: Professor E. Katchalski-Katzir, Weizmann Institute of Science; Professor D. Papahadjopoulos, University of California, San Francisco; Professor T. Chang, McGill University; J. Salk, M.D., Salk Institute.

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in winter, are obviously best for southern exposures because they let in most of the winter sun yet provide shade in summer. The bare branches of deciduous trees block out only about 25 percent of solar radiation, acceptable for passive solar installations. But where homeowners have invested in active solar systems that depend on capturing all available solar energy, tall trees must be pruned up to a high crown to provide summer shade but not affect winter sun; or the trees must be removed and replaced by low-growing species that will not interfere with winter sunlight.

Protection from the western sun may be achieved with either evergreen or deciduous trees because there is never any warming winter sun from that quarter anyway.

Wind: Winter Enemy, Summer Friend

Effective use of wind is at once the most overlooked energy-saving strategy and the easiest to achieve with landscaping. We all know that a 20-mile-per-hour wind makes a temperature of 50° F feel like 32° F, but we often fail to realize that this is as true for buildings as it is for people.

The prevailing winds (including the local winds near mountains and bodies of water and in cities) are the ones to work with for the best yearly savings. Storm winds tend to be gusty and erratic and therefore less significant. Fortunately, in most parts of the United States the prevailing winds differ in summer and winter, so landscaping that provides shelter from most winter winds need not impede cooling summer winds.

Windbreaks create protective wind shadows both upwind and downwind, the size and shape of which are determined by the height, shape, and character of the barrier. Such barriers can affect air movement for a distance three times their height to their windward and 30 times their height in their lee.

A solid barrier such as a wall or hill creates a windless space immediately in its lee that offers excellent energy-saving potential. A semipermeable barrier such as a thick hedge is most efficient at a distance to its lee of between 5 and 10 times its height. The optimal density of such a windbreak is about 60 percent; the idea is to try to dissipate the wind's force in the multiple twigs and branches and spaces, not just to buffet air up and over the barrier. If only a single row of trees is possible, use evergreens spaced only 6 feet apart—very close together. If space permits, use two rows 12 feet apart with trees at 8-foot intervals.

All these features should be located so that they offer protection from prevailing winter winds without affecting the prevailing summer winds. The latter not only provide constant natural air conditioning but can also lessen fungus and mildew buildup in moist climates. Indeed, some forms of landscaping can create a funnel effect that increases the velocity and therefore the cooling effect of summer winds.

Grass, Water, Pavement, and Snow

Since heat is absorbed differently by different materials, plants, walls, driveways, terraces, and pools can be very significant in determining the microclimate around a building. For instance, a south-facing white wall reflects heat and thus remains cool, but it also increases the heat reflected onto nearby outdoor areas. If a living area is involved, a medium color would be better.

A blacktop driveway that absorbs energy is preferred in the north, where winter heat is at a premium. To prevent this winter benefit from becoming a summer liability, plant a canopy of deciduous trees.

Shrubs, grass, and other groundcover plants absorb energy from sunlight and moderate summer temperatures in their vicinity. The "green-carpet" syndrome is hardly necessary. Though fine lawns require more maintenance than any other plant material (for mowing, fertilizing, watering, and herbicides and insecticides), plain grass, not too neat and fancy, absorbs just as much energy.

Snow is an excellent insulator. Twiggy shrubs that hold snow against a windy north face of a building will keep it warmer inside. However, nothing is without tradeoffs: the snow will delay the coming of spring on that wall.

The principles of good landscape design are consistent with these energy-saving strategies. The problem is that scientific energy-saving techniques have never been applied in a total systematic, calculated way. Beauty and function are synergistic, and the land around us provides many opportunities for significant energy savings. □

Ruth S. Foster owns a landscape firm, lectures extensively, and is the author of Landscaping That Saves Energy Dollars, *(David McKay, 1978).*

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An Outsider's View of the Soviet Space Program

Red Star in Orbit
James Oberg
New York: Random House, 1981, $12.95, 272 pp.

Reviewed by Charles Ball



Most Americans give marginal attention to the United States space program, so it isn't surprising that they have only a vague idea of what the Russians have done—and are doing—in space.

In *Red Star in Orbit* James Oberg makes a pitch for better coverage of Soviet space activities by the U.S. press, but he also offers ample evidence that a big part of the problem is the Russian penchant for secrecy and duplicity. The *New York Times* summed up the situation after the Russians recently returned two cosmonauts from their *Salyut 6* space station and announced that there would be no further manned space flights for a few months. "The ways of the Soviet Union's space program often seem as mysterious as the universe awaiting exploration. Only through sparse announcements after the fact and much analysis does the world discover what's up, what's down, and what's in the making."

A computer specialist at the Johnson Space Center in Houston and a respected Soviet space watcher, Oberg draws on a variety of official and unofficial sources, including reports from Soviet defectors and a network of amateur radio listeners around the globe, in his fast-paced, authoritative, reasonably comprehensive history of Soviet space efforts. He chronicles the deceits and disasters of the Russian program but keeps his gaze on the successes, too. Oberg suggests that the Russians may have decided to forego propaganda-geared space spectaculars for long-range effectiveness, a turning point that can only enhance an already formidable manned space program in which Russian cosmonauts, in aggregate, have spent more than twice as much time in space as their American counterparts. (Soviet cosmonauts also hold the space endurance record of 185 days, compared to 84 days for the United States.)

That the program has fared as well as it has, in spite of well-documented official meddling, is one of Oberg's main points. He is anything but an apologist for the Russian state system but is nevertheless a space enthusiast with an appreciation for the accomplishments of Russian cosmonauts and scientists. He has in fact dedicated the book to the late Sergey Korolev, the rocket engineer who survived Stalinist labor camps to become the guiding genius of the Soviet space program.

The New Journalism

Oberg has put ten years of research into his history, but he acknowledges that it can only represent an "overview" given the attitude of the Soviet Union, "where honest space history research is stonewalled." Tom Wolfe writes in the foreword that Oberg "is doing the work that Soviet historians should have embarked upon years ago but did not and, of course, never will."

In *The Right Stuff*, his book on the *Mercury VII* astronauts, Wolfe utilizes the so-called "new journalism" techniques to reconstruct the thoughts and actions of the astronauts. Oberg, who tells us he is fascinated by "the human angle," does the same. Thus, we find two cosmonauts inside their downed space capsule in a snow-filled birch forest somewhere in northern Russia, 2,000 miles from their target zone. "They were sitting in the dark," he writes, "and they listened to the snaps and growls of a pack of hungry wolves as they prowled outside their partially open hatch." Other writers have been justifiably criticized for taking such liberties, but Oberg uses the technique with restraint.

Tracing the Soviet space effort from its earliest years was a particularly trying task because of Soviet "misinformation, cover-up, and outright deception," says Oberg. He links an "appallingly high casualty rate" to hastily conceived and executed ventures, although he pretty much dismisses rumors of "secret dead cosmonauts."

He also gives an account—probably the most detailed yet—of the so-called Nedelin catastrophe, likely the worst disaster in the history of rocketry, although it remains a nonevent in the Soviet Union. Oberg offers strong evidence that the explosion of a launching pad in October 1960, three years after *Sputnik* and six months before Yuri Gargarin became the first space traveler, killed as many as 40 space specialists, including Field Marshal Mitrofan Nedelin, Russia's top missile general. The disaster supposedly occurred when Nedelin, under pressure to launch a "showcase" Mars probe, ordered technicians and others to the launch pad when the rocket failed to ignite, only to have it explode as they worked on it. It was not unlike someone walking over to inspect an unexploded firecracker.

Space One-Upmanship

According to Oberg, some largely political stunts included the 1963 flight of Valentina Tereshkova, the first (and thus far only) woman in space, and the more recent series of *Soyuz* guest flights by cosmonauts from Soviet-bloc nations. The fact that these trips are always commanded by a Soviet cosmonaut has produced some wry jokes behind the Iron Curtain. "Why weren't both Czech cosmonauts on board the two-person *Soyuz*?" goes one. "Because then they would have landed in West Germany."

Oberg tells us that all Soviet space stories are datelined "Baikonur Cosmodrome," although the actual launch site is

ILLUSTRATIONS: KATHERINE MAHONEY

more than 200 miles away in a town no longer on official Soviet maps. He also has a chapter on life in "Starry Town," home of members of the Russian space community.

Competition with the United States has shaped much of the Soviet space program, according to Oberg, and he thinks the Russians fully intended to send people to the moon ahead of the United States. But, he says, they let the world believe otherwise once they had been beaten—and were aided in the deception by a gullible U.S. press.

Oberg even suggests that the 1975 joint U.S.-Soviet space mission linking the *Apollo* and *Soyuz* spacecraft may have represented "the pinnacle of space image-manship." The Soviets wanted "to make up for their loss of face in the space race, to portray themselves as equal partners with the United States, even though they were not."

Then came a dramatic reversal: at some point, perhaps when the Soviets were willing to admit that they had lost the first phase of the space race, they made fundamental shifts in policy. "A long-range, unhurried development plan was drawn up," Oberg says, "and secure levels of resource allocation were guaranteed." While space funding in the United States plummeted, "the Soviets studied their mistakes, catalogued their capabilities, and set to work."

With the Russians now concentrating on long-duration space operations, Oberg predicts the next two decades will be "full of intense Russian manned space activity." As *Salyut 6* gives way to larger space stations for a dozen or more cosmonauts, the stage may even be set for a manned mission to Mars by the mid-1990s. □

Charles Ball, assistant director of the M.I.T. News Office, was an aviation and space writer for the former Boston Herald Traveler *for ten years.*

Engineering Values

Being Human in a Technological Age
Donald M. Borchert and David Stewart, eds.
Ohio University Press, 168 pp.

Reviewed by Miles Orvell

Carlyle complained as early as 1829 that "men are grown mechanical in head and in heart, as well as in hand." Today, we wake



up to radio music and traffic reports, plug in the coffee, work all day with our word (or food or whatever) processors, exercise in a mechanized health club, drive home, answer the calls recorded on our phone machines, climb into a vibrating bed, and fade out with the sound of a Moog on tape.

People and machines have grown so symbiotic that who knows anymore what "being human" means? Are we nearing the pinnacle of human achievement, as technologists would have us believe? Or are we walking backward into a pothole on a crumbling expressway? Where do things stand today in the long space of human spiritual history?

The editors of *Being Human in a Technological Age* have asked five distinguished philosophers, a social scientist, and a scientist-artist to address these questions in an effort to continue a dialogue inspired by C.P. Snow's famous utterance 20-odd years ago that Western culture has split in two—into the sciences versus the humanities—and that we must bridge the chasm or fall between. The result is a volume that explains, sometimes in overly familiar ways, how and why we've gotten ourselves to the point where we need to raise such questions, with perspectives both diverse and valuable.

A distinction the editors don't draw sufficiently in introducing the first essay, "The Humanness of Physics" by the physicist (and sculptor) R.R. Wilson, is that between science and technology. If science is the formulation and investigation of the laws of nature, and technology the application of those principles to the performance of specific tasks, then Wilson, unlike the other contributors, has much to say about science but little about technology.

Wilson sees the quantum physics of the twentieth century affording us a view of the world that is not closed and deterministic (inferences drawn from Newtonian physics), but rather open and surprising. People under the influence of modern physics are free and inquiring, appreciative of "the mysterious nature of our world." Moreover, for Wilson the method of the scientist is the method of the artist, for the former uses the language of aesthetics—beauty, balance, form, symmetry, subtlety—to evaluate and formulate the laws of science.

Wilson's essay, with its optimism about the possibility of unifying the cultures of science and art, calls on scientists (using Whitehead's words) to make "man, his culture, and his ideals of central importance" to science; otherwise we may sink to "the level of technologically skillful barbarians." And this is the nub of it: it's one thing to celebrate the creativity of the scientist cum artist; it's another to ponder the quality of a civilization wrought by the combination of technology, business, and industry.

The final verdict on whether technological civilization has sunk to Whitehead's barbarian level is not yet in, but several of the essays in this volume provide a perspective on the pros and cons of the consumer culture. The most positive statement is provided by philosopher Gerald F. Kreyche, who argues that "technology has wrought far more good than evil, and that what is needed in a world of 3.8 billion people is not less technology but more." The discount store and the supermarket especially are credited by Kreyche with contributing more to the common good than we like to admit. Yet Kreyche agrees with Gabriel Marcel that our great error lies in "thinking that a person *is* someone only so long as he *has* something"; the necessity of respecting the humanness of others, of loving others, is central to Kreyche's prescription for human culture. What's missing from the analysis is how we move from the A&P or K-Mart to a society that fulfills "higher" goals.

The social scientist Daniel Yankelovich looks at the contemporary K-Mart world and sees a society that is struggling toward higher goals in a variety of ways, not all of which he applauds. During the years of prosperity after the war, until the 1960s, Americans felt generally satisfied—they trusted government and institutions and had confidence in their own social mobility. This attitude has changed to a distrust of government, a sense that things are getting generally worse and that business does not serve the public interest.

The individual's discontent is reflected in a belief that on the one hand, certain basics—education, a decent standard of living—are "rights," and that on the other hand, these things are not enough: being human means fulfilling one's potential. Yankelovich views with mistrust this new narcissistic society fathered by Abraham Maslow, believing, with Kreyche, that a concern for others is essential to our survival and (less convincingly) a need of human nature. Yankelovich concludes that it is possible to have discount stores *and* a humane society, but that "it is going to take a lot of faith and hope and work to build it."

The other essays in this collection reflect more or less the same conclusion, though from quite different historical and philosophical perspectives. Theologist Langdon Gilkey argues that religion was displaced from Western consciousness as a salvational force because of our great success in using technology to solve all our problems. Now that it is clear that technology has brought us new problems—exhausting our resources, polluting our environment, limiting our freedom—we must return to a sense of religion to restore our freedom and harmony with the world. Paul Ricoeur, the political and social philosopher, argues that we must be receptive to the social inventions that are a part of utopian thought, for we need their constructive power to imagine alternatives to our present conservative ideology of technology. And Troy Organ, a student of Hinduism, offers Tagore's goal of "universal humanism, a union of the peoples of the world based on understanding and love," as a model for world order.

Faith, religion, universal love—being human to these writers means striving for some values beyond our personal gratification and private lives. Still, we close the book and look again at the technological age outside our window and realize a certain dissatisfaction with these formulations. The authors speak earnestly of the need for change without a sufficiently concrete sense of how things change and what the obstacles are.

If a philosopher tells us what human needs are, does the world listen? The split in our culture that Snow worried about and that the editors of this volume try to heal should perhaps be reformulated. It is not science or technology versus the humanities, but the world of ideas and the university versus the world of business and politics. The changes that affect our humanness in our technological age are occurring daily in board rooms and legislative assemblies. Can we count on the sagacity of our political leaders? Have you listened to the intellectual level of political discussion lately? It is the isolation of the university from American life that we should be worried about.

And it's the isolation of America as a whole from the rest of the world that we also should be worried about. We are not isolated politically, militarily, or economically from one perspective, at least: we protect our self-interest and those of our transnational corporations. But we *are* isolated from certain facts passingly mentioned in this volume that impinge from every angle on our sense of what being human is: that Americans have 6 percent of the world's population and exploit 40 percent of its resources; that each American pollutes, on average, as much "air, land, and water as do 80 Indians."

We don't need to emulate the poverty of India to redress this imbalance, but we need to do something. *That* is the responsibility of being human in a technological age, and this volume will contribute a little to discussions that ought to be constant and universal. □

Miles Orvell is an associate professor in the American Studies Program at Temple University. His last contribution to Technology Review *was "Technology and the American Dream" (October 1980).*

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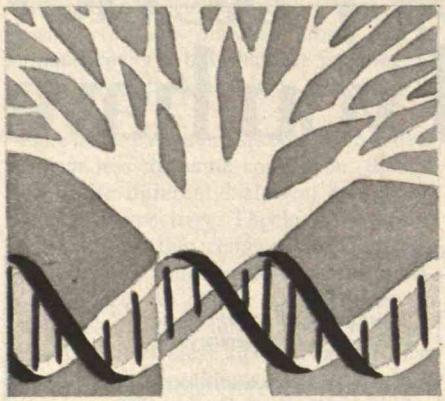
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Biological Backlash

Human Nature and History: A Response to Sociobiology
Kenneth Bock
Columbia Press, 1981, $18.75, 243 pp.

Reviewed by Jon Beckwith



Human sociobiology is the latest in a long line of theories arising out of the biological sciences that claim to bring us new understanding of human social arrangements. A number of its advocates propose that sociobiology is essential to the formation of social policy, and not a month goes by without one or another popular magazine presenting the views of sociobiologists on various issues of social significance. For instance, the February 1981 issue of *Psychology Today* includes an interview with sociobiologist Donald Symons, who proposes that the sexual double standard is "built into our genes." In light of this widespread response, it would seem that human sociobiology has considerable substance and scientific weight behind it. It does not.

Given the repeated instances of acceptance of similar now-discredited theories, we should approach this new example with a certain degree of skepticism. Even sociobiologists will admit that their theories on human social behavior are speculative and that they are awaiting the "hard data" to back them up. Geneticists have shown how genetic theory cannot usefully be applied to the kinds of questions sociobiologists tackle. Anthropologists have described the misrepresentation of early hominid history in sociobiology, and the lack of coherence of the sociobiological theory of kin selection with the results of anthropological studies.

Now, Kenneth Bock, a sociologist from the University of California at Berkeley, examines sociobiology from a new perspective. In contrast to previous critiques, Bock does not focus on the theory's specific flaws or its failure to account for various social phenomena. Rather, he describes the rich tradition of social commentary dealing with explanations of human history and the differences in the development of different cultures. He covers enormous ground in this short book, referring to the writings of Auguste Comte, David Hume, Jeremy Bentham, John Stuart Mill, Theodor Waltz, Frederick Teggart, and Arnold Toynbee, among others. In part, the book appears to be an attempt to shame sociobiologists into recognizing that in reviving the "atomistic view of human groups," they have shown an extraordinary lack of interest in human history and "the effects of association, interaction, tradition, and common human historical experience in human life." He reminds us that "Comte argued that human nature changes over historical time as a result of the accumulated experiences of successive generations. There is, therefore, no universal or abstract human nature, no human being as such, but only historical human beings." According to Teggart, Park, and Toynbee, "People created social structures and cultural forms and in so doing shaped themselves."

This critique hits the mark. The ahistorical nature of most human sociobiological theorizing is striking. Wilson's trivialization of human social and cultural changes, obscured in complex mathematical expressions, has eliminated human history as a factor in our understanding of who we are and where we are going. Wilson says that in predicting the future behavior of groups, we need know only the proportion of people currently exhibiting a behavior and understand its genetic basis; no history or memory need be taken into account. To accept this premise requires a considerable leap of faith.

For instance, should we attempt to fathom the evolution of public opinion on the United States' involvement in El Salvador simply by examining the distribution of current attitudes and invoking a hypothetical genetic predisposition toward aggression? Or, rather, should we take into account the history of this country's actions in Vietnam and numerous other historical factors?

Bock shows how Darwin put forth many of the same speculations about human nature that the sociobiologists now propose. In *The Descent of Man*, Darwin developed evolutionary explanations for what he believed to be the natural inferiority of women and non-European groups. Furthermore, the thrust of his analysis was "to deny that historical experience has any other source or substance than in the individual biological qualities of men, and that historical processes have no effects in themselves." Nineteenth-century humanists found as little value in such speculations as social scientists today.

One of Bock's major reservations is that sociobiologists have ignored cultural differences and focused only on human universals, thereby overlooking a central function of the social sciences. However, sociobiologists are now beginning to approach these questions. They may have avoided the issue of cultural differences in the past because of fears of becoming embroiled in arguments over racism. But the fact that they are beginning to incorporate these issues into the theory without changing their fundamental approach does not lessen the validity of Bock's criticisms.

Given that sociobiology has been the subject of such serious criticism from a variety of disciplines, including Bock's, we must wonder at the rapid and widespread popularity the theory has achieved in such a short period. Theories such as this, which propose a genetic explanation for human social questions, came into disrepute after World War II as part of public reaction to the Nazis' horrifying extension of these ideas into genocide. If sociobiology had been proposed in the late 1940s or 1950s in this country, it would almost certainly have been ignored.

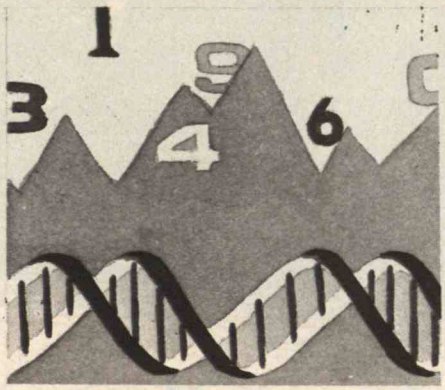
But after two decades of social agitation in which women, minorities, and the poor have been pressing society for a greater share of wealth and power, genetic explanations for the inequalities of race, sex, and class are received with interest. As *Time* magazine put it in a cover story in 1977, "Sociobiology may have appeared at the right cultural moment. The 1970s have brought with them growing impatience and disillusionment over failed educational and environmental experiments designed to alter social behavior. At such a time, the emergence of a doctrine preaching that man is caught in history, able to exercise free will only within the limits set by their genes, may do very well indeed." □

Jon Beckwith is American Cancer Society Research Professor of Microbiology and Molecular Genetics at Harvard Medical School. He has published articles on sociobiology, genetic screening, genetic engineering, and the social responsibility of scientists.

A Misguided Mathematical Model

Genes, Mind, and Culture
Charles J. Lumsden and Edward O. Wilson
Harvard University Press, 1981, $20, 428 pp.

Reviewed by David Layzer



In *Sociobiology* and *On Human Nature*, Harvard biologist Edward O. Wilson argued that cultural universals such as religion and incest taboos have a genetic basis. In this book Wilson and coauthor Charles J. Lumsden, a physicist and Harvard research fellow, argue that cultural diversity also has a genetic basis.

"Coevolutionary theory," the authors explain, is "an extension of sociobiology that creates an internally consistent network of causal explanation between biology and the social sciences. It is designed to include all cultural systems, from the protocultures of macaques and chimpanzees to the euculture of human beings, as well as forms of culture hitherto conceived only in the imagination." It will, they say, enable investigators not only to explain history but "even to predict it with moderate accuracy."

Evolutionary biologists have traditionally taken a skeptical attitude toward such propositions. In *The Biological Basis of Human Freedom* (1956), Theodosius Dobzhansky remarked that "some rather naive attempts have been made, chiefly by nineteenth-century biologists, to find a biological basis for some common denominators [among all cultures]. The results were unconvincing, and modern anthropologists, as well as biologists, are justifiably skeptical about their usefulness. It is futile to look for genes which cause mankind to invent bodily adornment, etiquette, incest taboos, numerals, or soul concept. Such genes do not exist."

It is generally agreed that language lies at the heart of culture. Thus, if cultural diversity has a genetic basis, so must linguistic diversity. Conversely, if there is no evidence that the diversity of human languages, and of those aspects of culture that depend directly or indirectly on language, has a genetic basis, is it reasonable to seek a genetic explanation for biologically less important cultural differences? Do American-born Chinese learn to speak, read, and write English less readily than Americans of European ancestry? Do Chinese-born Americans learn to speak, read, and write Chinese less readily than people of Chinese ancestry? Similar questions can be asked about music and mathematics.

Anecdotal evidence suggests that the answer to all these questions is no—that human infants are culturally unbiased. Lumsden and Wilson do not present any contrary evidence. Instead, they claim to *deduce* the existence of innate cultural biases from a set of postulates: that culture is made up of discrete units, each a "relatively homogeneous set of artifacts, behaviors, or . . . mental constructs," and that cultural behavior consists of choosing among or switching between members of such (apparently ready-made) sets. The choices and switches individuals make are determined by probabilities coded in their genes. The authors conclude that cultural evolution results from changes in the composite of cultural choices made by members of a given population.

Clearly Lumsden and Wilson have a very different picture of culture from those who stress the pervasive and unifying function of systems of belief, meaning, and value. They also view cultural evolution differently from those who stress its innovative character—those who would argue, for example, that the rise of technology involved more than a rash of individual decisions to start using electric lights and cars instead of candles and horses.

Lumsden and Wilson present "gene-culture coevolution" as a deductive mathematical theory based on well-established postulates. These include a simplistic account of the functioning of the human mind based on the much-disputed "information-processing theory," which proposes that mental activity consists of a computerlike processing and storage of information. Their main conclusion is that small changes in the genetic composition of a society are likely to be amplified when translated into behavior and to "have dramatic impact" on cultural patterns.

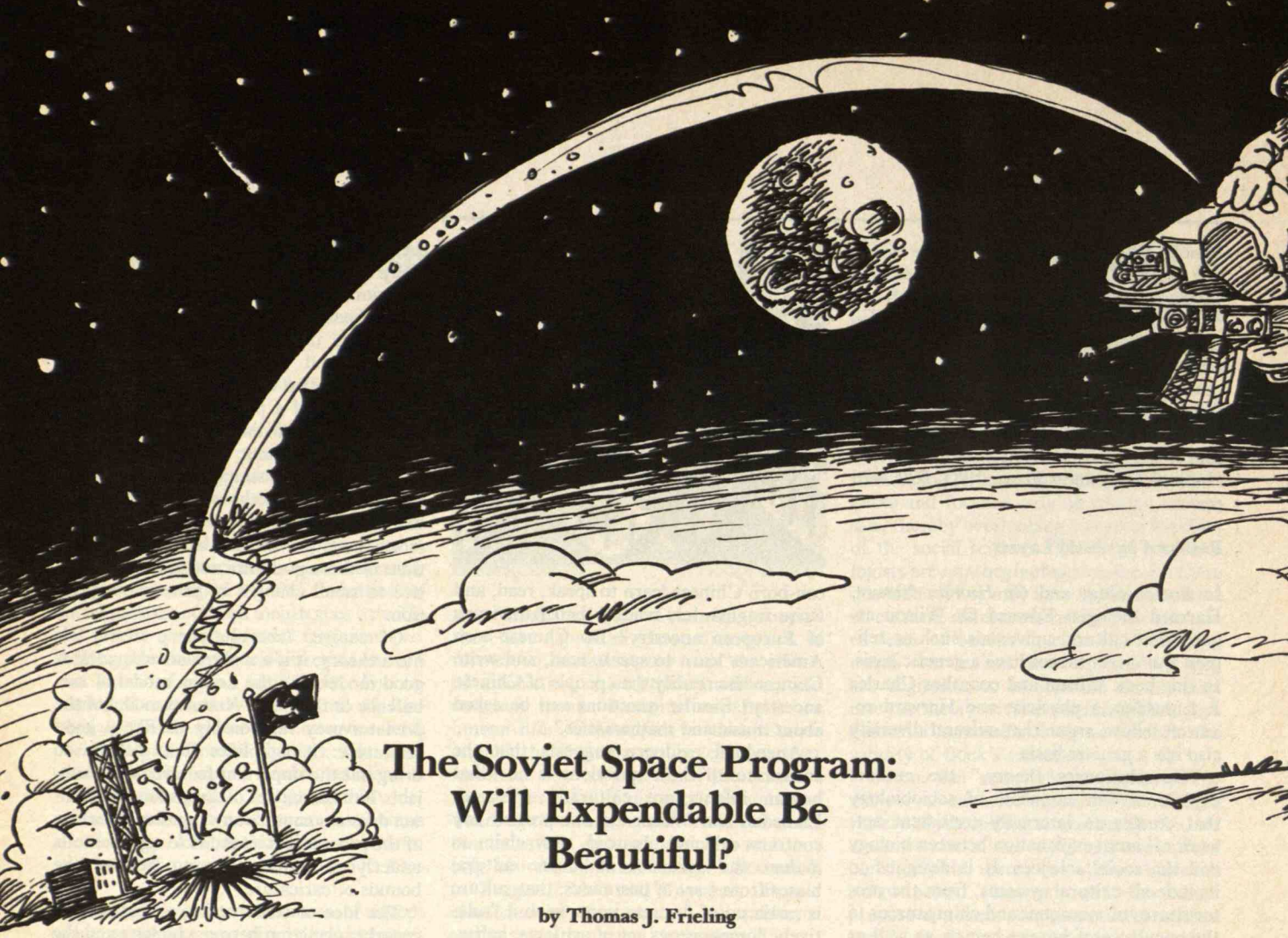
In fact, this conclusion is not valid. Lumsden and Wilson deduce from their assumptions that the probability that a certain fraction of a population engages in a given social behavior depends very sensitively on the genetic composition of the society, but this is simply a consequence of the fact that when the population is large, the probability profile consists of one or more sharp peaks. The heights and positions of these peaks are not generally sensitive to small changes in genetic composition.

Of course, "coevolutionary theory" is not a theory; it is a mathematical model. A good model, like the Lorenz model of turbulence or the Lotka-Volterra model of the predator-prey relationship, is like a good caricature: it simplifies and distorts to bring out the important features of its subject. But the model of Lumsden and Wilson does not capture any significant feature of the process it is intended to represent; its underlying assumptions go beyond the bounds of caricature.

The idea of constructing a "network of causal explanation between biology and the social sciences [that would] include all cultural systems, [even those] hitherto conceived only in the imagination," reflects both a greatly exaggerated estimate of what can be accomplished through mathematical modeling and an excessively narrow view of mind, culture, and evolution. Human intelligence is above all a capacity to invent novel solutions to unforeseen and unforeseeable problems. Biological evolution also creates novel solutions to unforeseeable problems and exploits unforeseeable opportunities. Cultural evolution is equally innovative and unpredictable.

In the physical sciences, understanding and prediction usually go hand in hand; in biology often they do not. To say that evolution is an essentially innovative, and hence unpredictable, process is not to say that its underlying mechanisms cannot be fully understood. But to ignore the innovative aspects of biological and cultural evolution, as Lumsden and Wilson do, is to ignore their most distinctive and important characteristics. □

David Layzer is Donald M. Menzel Professor of Astrophysics at Harvard University and has published several papers on biological evolution and population genetics.



The Soviet Space Program: Will Expendable Be Beautiful?

by Thomas J. Frieling

ONE of the enduring mysteries of the Soviet space program has been the so-called Soviet superbooster, variously referred to as the G-1, the TT-5, or Webb's Giant. Ever since the late 1960s when James Webb, the NASA administrator, warned that the Soviets would soon launch a rocket "more powerful than the *Saturn V*," the West has watched and waited for the giant's appearance. The wait has been in vain: the G-1 booster has yet to join the operational family of Soviet launch vehicles.

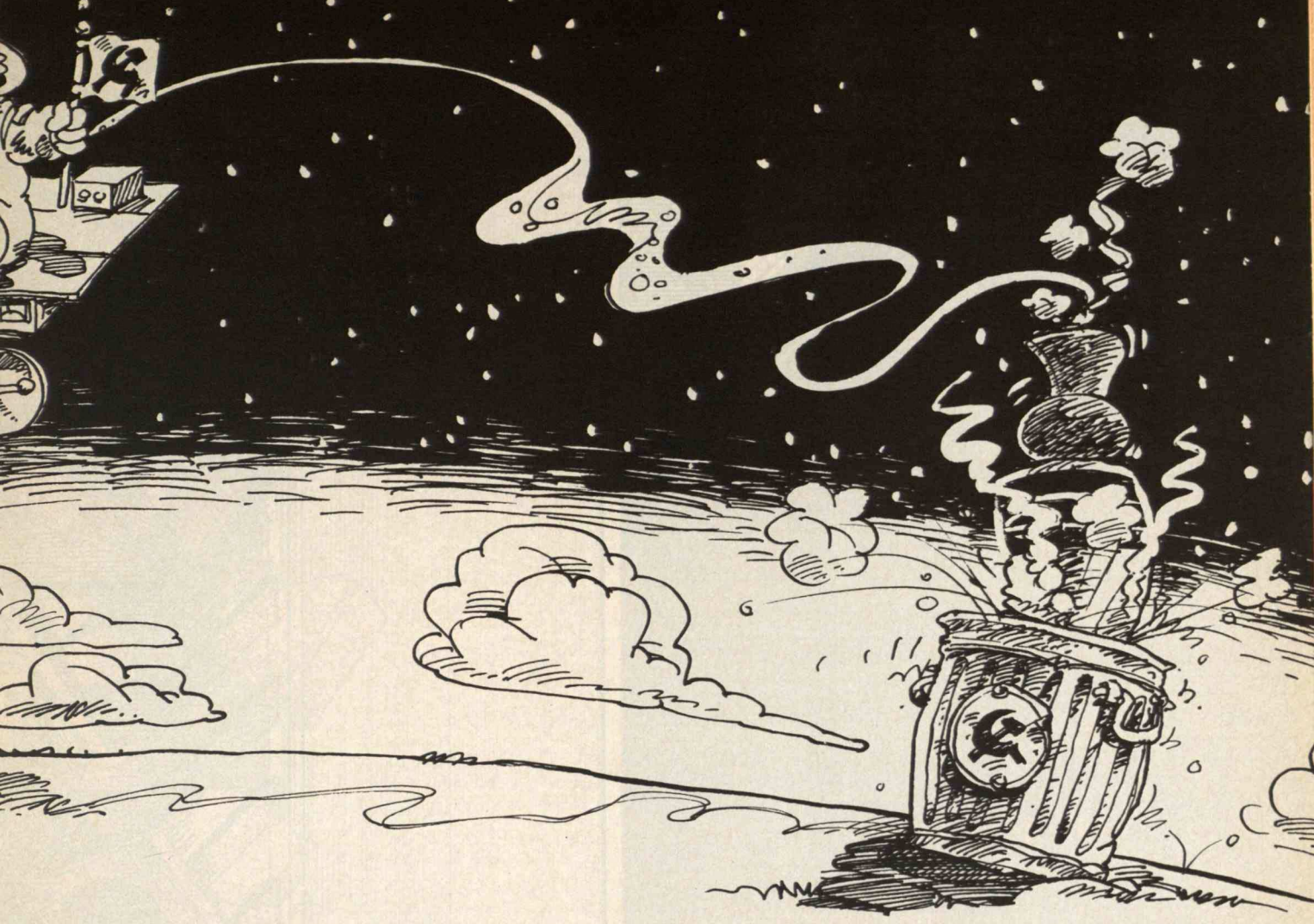
Some space experts doubt whether it ever existed. They suggest that the G-1's persistent appearance in Western press reports was merely a NASA device to maintain the appearance of a vigorous space race so that Congress would be less likely to cut the space budget. Indeed, the appearance of a *Saturn V*-class booster would have been the final piece of evidence that the Russians' goal was to beat the Americans to the moon: a booster of that size could have had no other purpose during the late 1960s. But the evidence never materialized.

However, lack of proof does not mean that the superbooster never existed—it did. Webb's original statements were based on photographs taken by U.S. Air Force reconnaissance satellites of construction of launch-pad and launch-support facilities at the Soviet space center near Tyuratam. These photographs are classified and have never been made public, but they are undoubtedly still on file in government archives. But Landsat photos are *not* classified —on June 2, 1977, *Landsat 1* passed over Tyuratam and took a photo that clearly shows the G-1 launch pad.

Western observers believe that development of the G-1 began around 1963, its role being to send Soviet cosmonauts to the lunar surface before the Apollo astronauts. Analysis by various intelligence and space experts has produced a picture of a truly enormous three-stage launch vehicle—400 feet tall with a 50-foot diameter at the base, a total weight of about 7.7 million pounds, and a first-stage thrust of 10 to 14 million pounds achieved by 42 engines (an incredible number: *Saturn V*'s first stage had just 5). But even with a thrust almost twice that of *Saturn V*, the G-1's lifting capacity is not twice as great because of the lack of high-energy propellants (such as the liquid hydrogen used by *Saturn V* in its upper stages). The G-1's estimated lifting capacity is 340,000 pounds for low-earth orbit; that of *Saturn V* is 280,000 pounds.

Trouble with a Capital G

Western experts believe that the first flight-test vehicle arrived on the pad for checkout in February 1969; by June it was ready to launch. But during countdown a large fuel leak in the second stage caused a fire that quickly engulfed the entire vehicle. The ensuing explosion not only destroyed the vehicle but the launch-pad support facilities as well. It took the Soviets two years to rebuild facilities for another launch attempt in June 1971. This time the countdown was successfully completed but the engines failed during ignition. When they tried again in August, the vehicle finally lifted off. However, an unknown failure liter-



JON McINTOSH

ally ripped the booster apart as it was nearing "max Q"—the period of maximum aerodynamic stress—at an altitude of 40,000 feet. It was back to the drawing boards one more time.

After two such spectacular failures, one might expect a new and improved model. The third G-1 booster, launched in November of 1972, was initially successful—this time the booster passed through max Q—but disaster struck once again. Before the second-stage engines were ignited, the vehicle exploded.

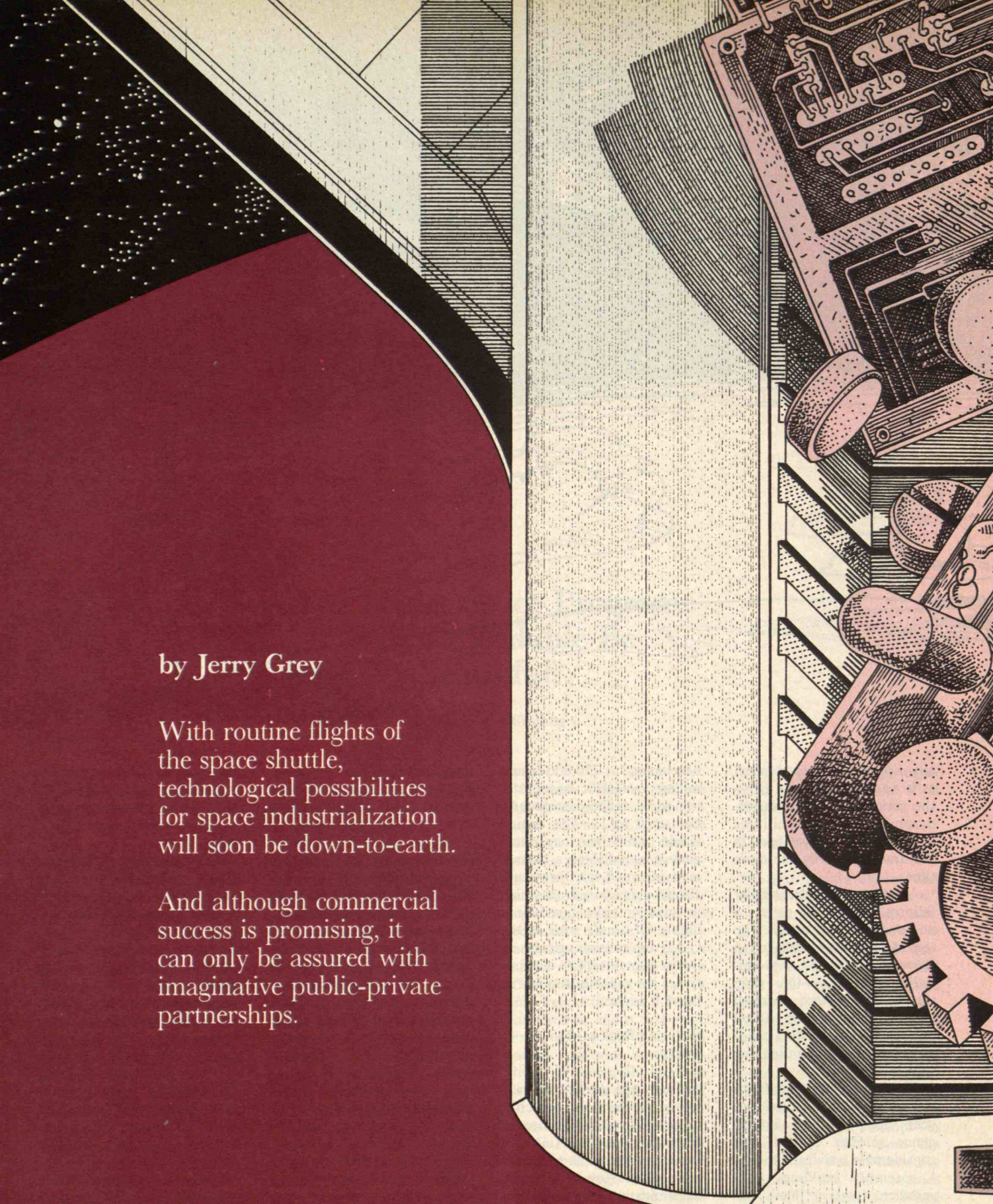
There have been no flight tests of the G-1 in almost nine years now, but U.S. intelligence sources confirm the considerable activity at the G-1 assembly building. Last summer *Aviation Week and Space Technology*, the authoritative space magazine, reported that the Soviets were developing a 220,000-pound military/scientific space station to be staffed continuously by a crew of 12. This station would fulfill their long-stated goal of establishing a permanent manned platform and also provide a base from which to launch initial manned lunar flights. Of course, work on the G-1 is also continuing since no Soviet launch vehicle currently has the capability to loft so heavy a payload.

Reaching Backward to Advance

But why are the Soviets persisting in developing such a huge expendable booster when the reusable American space shuttle seems to be the wave of the future? Dogged determination is no doubt part of the reason, but the Soviets' inability to introduce high technology into their program explains even more. For instance, U.S. spacecraft have had on-board computers ever since the Gemini program in 1965, but the Soviets flew the first computer on a manned spacecraft (*Soyuz T*) only last year. And the Soviets have never launched a high-energy hydrogen-fueled upper stage as the Europeans did with Ariane in 1979 and as the United States has been doing since *Centaur*'s first flight in 1962. In fact, all the extant Soviet designs for manned-spaceflight hardware are at least 10 years old, in the case of Salyut, and as much as 12 years old in the case of Soyuz (the new Progress vehicles are merely unmanned Soyuzes). Their launch vehicles are even older—the Soyuz launcher is essentially the same booster that launched *Sputnik I* in 1957. But innovative exploitation of this hardware during the 1970s has allowed the Soviet Union to surge ahead of the United States once again in the area of manned space flight.

However, the Soviets must surely realize that once the shuttle is operational the United States will quickly regain the lead. Ironically, the Soviets must now reach backward to advance, completing their 18-year-old G-1 booster program in order to launch their new and much larger space station. Whether the Soviets can finally solve the G-1's problems and thereby advance to permanently manned space platforms remains to be seen. It will be interesting to watch. □

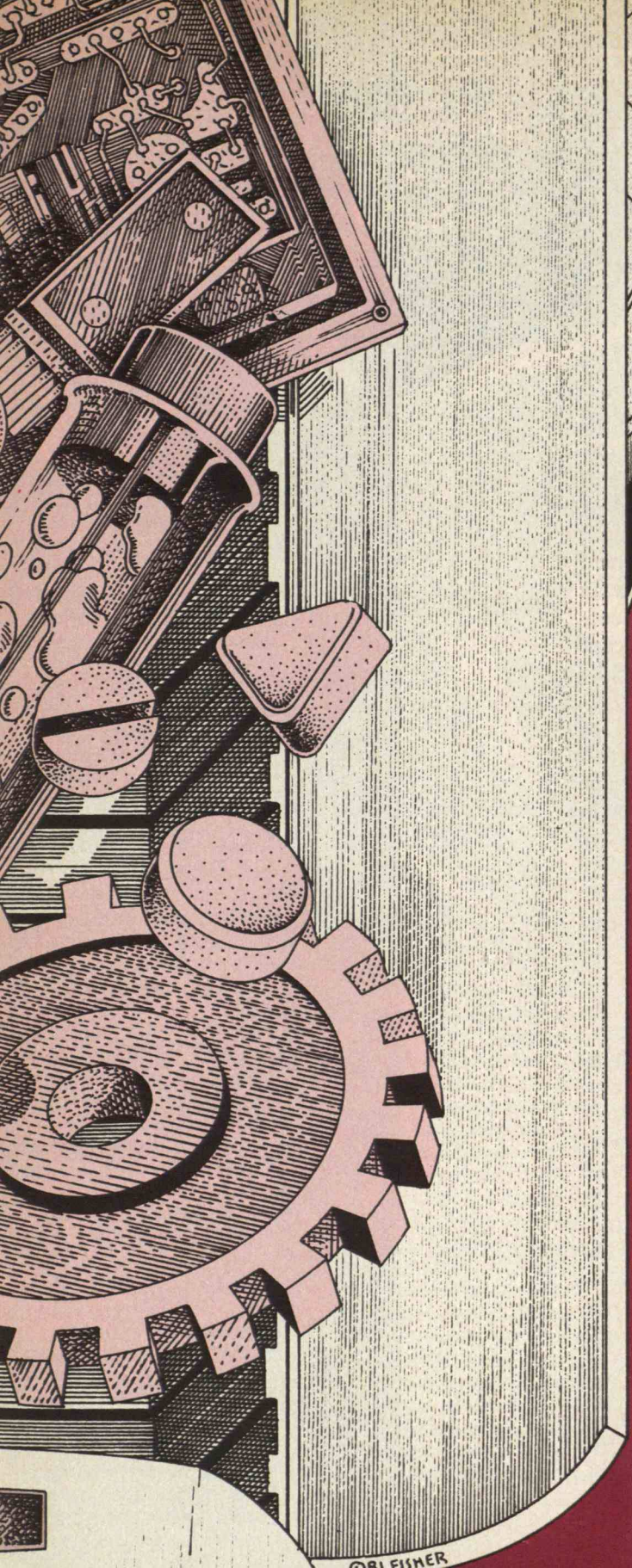
Thomas J. Frieling is executive director of the Campaign for Space Political Action Committee based in Bainbridge, Ga.



by Jerry Grey

With routine flights of the space shuttle, technological possibilities for space industrialization will soon be down-to-earth.

And although commercial success is promising, it can only be assured with imaginative public-private partnerships.



ILLUSTRATIONS: MARK FISHER

Implications of the Shuttle: Our Business in Space

THE space age was formally launched by the Soviet Union on October 4, 1957 when *Sputnik I* began beeping its primitive signals to an astounded world. In fact, this historic event has often been compared to the 1903 flight of the Wright brothers. But just as the age of avia-

tion really began in earnest in the early 1930s with the maiden flight of the DC-3—the first transport airplane that was clearly economical—space flight left its adolescence in April of 1981 when the U.S. space shuttle successfully completed its first orbital flight test. Indeed, the shuttle has often been nicknamed "the DC-3 of space." Although that is perhaps an overly generous image in view of its marginal economics, the shuttle's debut marks the most significant milestone in space flight: the advent of airplanelike reusability.

Until now, every spacecraft lofted into orbit or beyond was expendable; that is, the entire launch vehicle was discarded after it performed its task. For example, *Saturn V*, which carried the U.S. Apollo astronauts to the moon, cost over twice as much as our largest airplane, the C-5A military transport. However, no one would dream of throwing away an entire C-5A after only a single flight, as we did with our *Saturn V*s.

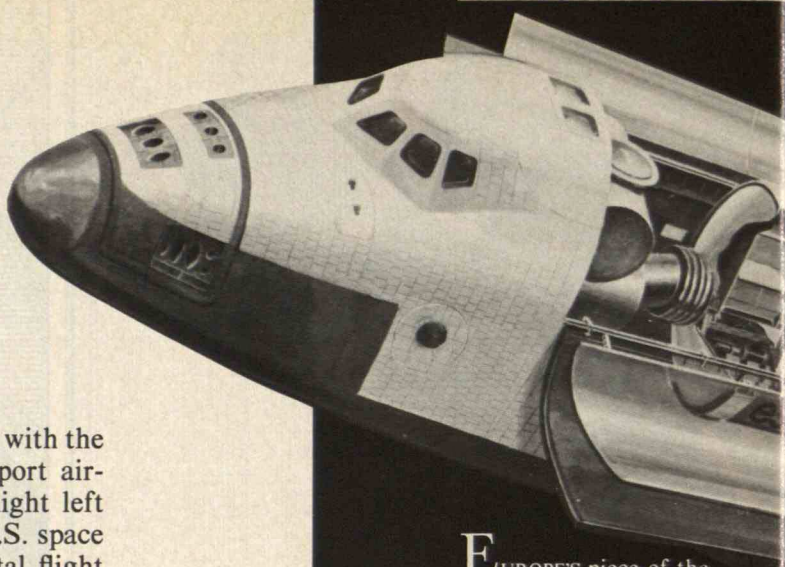
Earthly Constraints



THE CONCEPT of a reusable, reliable, and economical vehicle to launch payloads into space was proposed as early as the mid-1940s. But the actual technology—to build reusable high-performance rocket engines; to withstand, time after time, the inferno of atmospheric reentry at meteoric velocities; and to control the incredibly rapid dynamic motion of a winged, rocket-powered space launcher flying at hypersonic speed—just wasn't available until recently.

But as with virtually all new technologies, develop-

NASA PHOTO



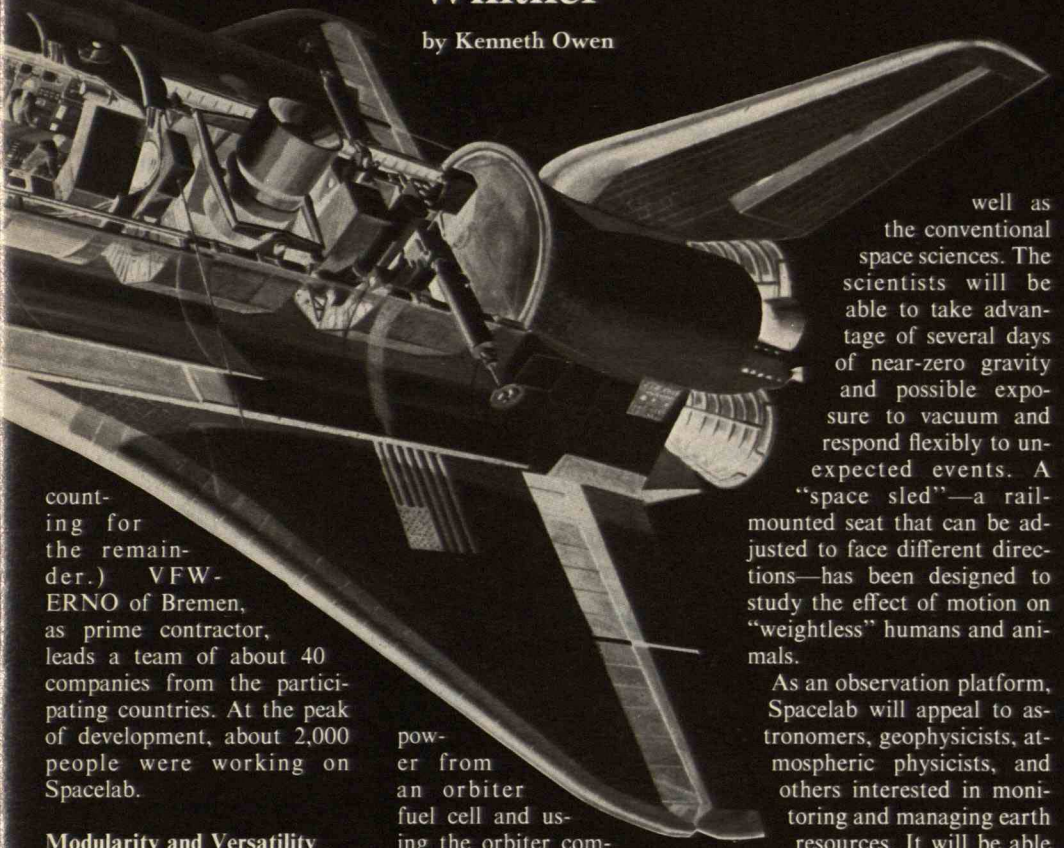
EUROPE'S piece of the space-shuttle action is Spacelab, the manned laboratory that will fit into the orbiter's cargo bay and make extended observations on selected scientific flights.

The program began in 1973 with a formal memorandum of understanding between NASA and the European Space Research Organization (ESRO), which in 1974 became the European Space Agency (ESA). Under the terms of the NASA/ESRO agreement, Spacelab has been designed and developed by Europe, at Europe's expense. And the first Spacelab—reusable, like the shuttle orbiter that will carry it—is being provided free for joint Euro-American scientific flights. Last year NASA signed a contract with ESA for the purchase of a second Spacelab.

If all goes according to plan, the first Spacelab mission will be launched in September 1983 and will last for one week. Two payload specialists, one American and one European, will be aboard. That flight will be the culmination of a ten-year, $950-million development program shared among ten European nations. (West Germany's commitment is by far the greatest, with 55 percent of total Spacelab costs. Italy is next with 16 percent, followed by France with 10 percent, the United Kingdom with 7, Belgium with 4, Spain with 3, and the Netherlands, Denmark, Switzerland, and Austria ac-

Spacelab: Whence, and Whither

by Kenneth Owen



counting for the remainder.) VFW-ERNO of Bremen, as prime contractor, leads a team of about 40 companies from the participating countries. At the peak of development, about 2,000 people were working on Spacelab.

Modularity and Versatility

Spacelab consists of two sections, the pressurized manned laboratory module and an unpressurized pallet with instruments (telescopes, antennas, and other sensors) that are exposed to the space environment when the orbiter cargo-bay doors are open. The manned module comes in two cylindrical segments: a core module housing central systems and basic workshop space, and an optional additional workshop area. The instrument pallet can also extend from one to five segments. In this design, module and pallet segments can be used together or separately as required. When only pallets are used, essential control systems are enclosed in a small pressurized container known as an igloo.

The Spacelab remains in the orbiter cargo bay throughout the flight, drawing electric power from an orbiter fuel cell and using the orbiter communications systems for ground contact. (Data from the Spacelab will be relayed to earth via the tracking and data relay satellite in geosynchronous orbit.) Spacelab's thermal control is integrated with that of the orbiter, and there is a tunnel through which the payload specialists and the flight crew can move between the laboratory and the orbiter cabin.

In essence, Spacelab is a housekeeping base for a variety of instruments and experiments that can be installed aboard the spacecraft almost as easily as in an earth-based laboratory. Depending on the equipment carried, it may be used as a research laboratory, an observation platform, a test bed, or, eventually, a production facility.

As a research laboratory, it will serve specialists in materials science, fluid dynamics, life sciences, and biology as well as the conventional space sciences. The scientists will be able to take advantage of several days of near-zero gravity and possible exposure to vacuum and respond flexibly to unexpected events. A "space sled"—a rail-mounted seat that can be adjusted to face different directions—has been designed to study the effect of motion on "weightless" humans and animals.

As an observation platform, Spacelab will appeal to astronomers, geophysicists, atmospheric physicists, and others interested in monitoring and managing earth resources. It will be able to maintain large payloads in precise attitudes, while the shuttle will allow many choices of orbital height and inclination.

The Spacelab can also be used as a test bed—to modify large, expensive, and complex systems before they are deployed as free-flying spacecraft—and for materials processing in space. Spacelab could follow the lead of *Apollo*, *Skylab*, and *Apollo-Soyuz* in exploiting the near-zero gravity and ultrahigh vacuum of space to produce pure and uniform materials such as new forms of glass, metal alloys, and pharmaceuticals.

Integration and Unification

Michel Bignier, the former head of the French national space center who is now director of space transportation systems for ESA, says that technical development of Spacelab "was not a big problem. It was a lot of small problems." For example, NASA increased the structural strength requirements for Spacelab at a late stage (early 1980), obliging the European designers to recheck and, where necessary, reinforce.

Development of an environmental control system to keep the "shirtsleeved" occupants comfortable inside the workshop part of the Spacelab was also new to European scientists, although appropriate technology was transferred from NASA to ESA and from U.S. industry to European companies. However, European delays on Spacelab were less than U.S. delays on the main shuttle program; according to Bignier, "We are only one and a half years late."

Integration of the basic Spacelab with its first payload—a complex assembly of 24 experiments—will keep ESA and NASA teams busy for much of next year. Later the complete Spacelab will be integrated with the shuttle orbiter, a significant advance for the European aerospace industry.

Spacelab represents three important benefits for Europe: it is a move toward better international collaboration, replacing the previous "your ball, my bat" philosophy; it gives Europe the opportunity to move from unmanned to manned spaceflight; and it especially fosters cooperation among European countries. Space technology in Europe has been unduly fragmented in the past; ironically, America's shuttle should help unify Europe's own space program. □

Kenneth Owen, formerly technology editor of The Times *of London, is now a free-lance writer.*

In the past, expendable launchers imposed overwhelming constraints on payload. The shuttle brings a new range of possibilities.

ment of a reusable launch vehicle was inextricably tied to complex economic and political issues. The need for a space shuttle—a launcher that could routinely travel between earth and low-earth orbit to emplace, retrieve, and service payloads—was foreseen by the U.S. National Aeronautics and Space Administration (NASA) long before the first moon landing. But when NASA announced ambitious plans in 1969 for a shuttle-supported permanent orbiting space station to support a regular lunar ferry and enable the exploration of Mars by manned spacecraft, political reverberations almost destroyed the agency.

The spectre of double-digit inflation, the escalating costs of the Vietnam War, and the urgency of social problems in rapidly deteriorating U.S. cities made multi-billion-dollar space adventures appear frivolous. The only project in NASA's grand plan to survive was the reusable shuttle, but even then many budget compromises had to be made. The Office of Management and Budget told NASA that its $10-billion (1970 dollars) shuttle design was incompatible with national priorities. OMB said, in effect, "You've got $5 billion—take it or leave it."

NASA took it. The agency also had to swallow a host of severe design specifications imposed by the air force (military missions, in large part, were used to justify federal funding). The most costly were the increase in payload capacity from the original 11,000 kilograms to 30,000 kilograms, the large size of the payload bay (20 meters in length and 4.5 meters in diameter), and the 1600-kilometer "cross-range" maneuverability so that the shuttle could land at its original launch point after a single orbit.

These constraints, together with the need to use three critical but largely unknown technologies—reusable rocket engines, a reusable thermal shell, and a computerized on-board flight-control system—required NASA to compromise on its basic goal of shuttle reusability. The orbiter was designed to be reusable for 100 flights, the main engines for 55 flights, and the solid-rocket boosters for only 10 flights. The big aluminum propellant tank, the core of the shuttle vehicle, is discarded after a single use, just like launchers of old.

Nevertheless, the shuttle does bring a whole range of new capabilities. In the past, expendable launchers imposed overwhelming constraints on the size of payloads. On the shuttle, payloads are constrained primarily in terms of length; diameter and mass are relatively unimportant. This, in turn, determines the number of different payloads that can be launched in a single flight. Shuttle payloads resemble a tuna can more than the familiar projectile shape, offering whole new design vistas. For example, solar panels and large antennas which are wide rather than long can now be carried and deployed more efficiently.

Even more important are the shuttle's operational characteristics. For example, its maximum acceleration is much lower than that of previous expendable launchers, easing requirements for robustness. And the availability of astronauts to check out payloads prior to their deployment in space sharply reduces the need for performance-assurance equipment. The shuttle also offers considerable flexibility in orbital altitude and inclination.

Capital Ventures in Space



COMMUNICATIONS have so far comprised the bulk of "space industry." A whole new spectrum of communications services—cable television, direct-broadcast satellites, global search-and-rescue capability, remote medical diagnostic services, secure business communications, personal "wrist radios," navigation aids, electronic mail, and package locators—and a host of other esoteric applications have been proclaimed as not only technically feasible but economically practical within a decade or so. And these systems don't include the enormous potential of existing NASA Landsat satellites and their successors, both U.S. and foreign, to develop whole new industries. These satellites will be able to monitor global production of key crops such as wheat, document the encroachment of crop diseases, detect unlawful sources of air or water pollution, observe and take action against desertification and plagues such as locusts; track and predict the navigation-threatening movement of ice floes; forecast floods and hurricanes; and search for oil and other valuable minerals.

But the most exciting future for space industriali-

Four space-manufacturing activities seem especially promising: pharmaceuticals, electronic devices, glass products, and advanced alloys.

zation involves the use of the space environment itself—especially the application of microgravity ("zero-g") to industrial processes. However, aside from a few exploratory experiments, the only in-space research facilities currently reside in the Soviet *Salyut 6* space station. Spacelab and the shuttle, the basis for the West's civilian space-test program, are not yet in use (*see p. 37*). Although it might seem impractical to make investments in any space industry on the basis of future experiments, the precursors to these enterprises are already growing rapidly.

Late in 1977, when NASA began its efforts to interest commercial investors in the use of the space environment, industry's response was virtually a flat "no." Potential returns were too far off, and appropriate directions for research and development had yet to be defined. Nonaerospace companies, many of which could realize the greatest benefits from industrial growth in space, were cool toward committing any funds. Yet NASA persisted with the aid of several aerospace companies—notably TRW, McDonnell-Douglas Astronautics, and Rockwell International—as well as the American Institute of Aeronautics and Astronautics (AIAA).

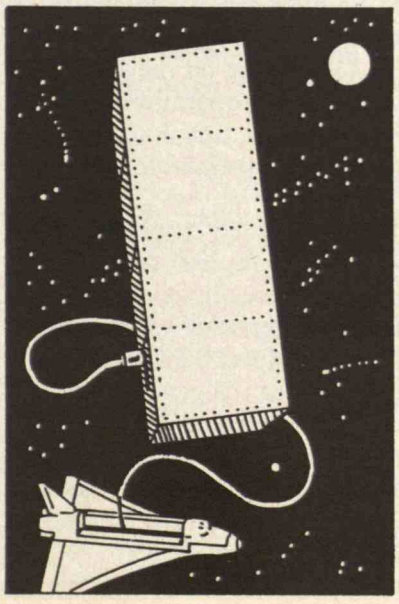
These efforts bore fruit in 1979 with the signing of an unprecedented agreement between NASA and McDonnell-Douglas Astronautics, which in turn signed an agreement with a nonaerospace "user" corporation (Ortho Pharmaceutical, a subsidiary of Johnson & Johnson). The aim was to evaluate prospects for the space-based manufacture of drug feedstocks, such as vaccines, that require a delicate process called electrophoresis. Experimentation on *Skylab* back in the early 1970s had indicated that yields of relatively pure materials could be much higher when molecular separation (the basis of electrophoresis) was not complicated by gravity-induced convection and sedimentation.

This cooperative agreement was an imaginative legal milestone: it gave Ortho sufficient proprietary rights to the test data to make the sizable investment financially attractive without violating federal antitrust or freedom-of-information statutes. Furthermore, it clearly demonstrated that the federal government was willing and even eager to subsidize this new industry, just as it had done previously with Comsat Corp. and more directly with aviation systems.

A number of similar cooperative agreements are currently being negotiated. One, with a small company called Microgravity Research Associates, would fund experiments to determine whether space processing can substantially improve the purity, and hence the performance and value, of microprocessor materials. Weightlessness eliminates the need for containers in a space-based process, a major source of impurities and surface irregularities. The absence of buoyancy and thermal convection also assures uniformity (*see "The Promise of the Space Factory" by Donald M. Waltz, May 1977, p. 39*).

But perhaps most important, many nonaerospace companies, which only two years ago shunned investments in space industrialization, have begun investing in preliminary microgravity experiments. One of the leaders has been John Deere & Co., manufacturer of tractors and farm equipment. After committing several hundred thousand dollars to NASA materials-processing technology, Deere began to perform tests in NASA KC-135 aircraft (with flights that offer 30 to 45 seconds of simulated microgravity when the centrifugal force of the "outside loop" essentially cancels the gravitational force). Deere wanted to learn more about the commonly used but poorly understood process whereby molten iron solidifies into the cast iron that forms the bulk of Deere's products.

Other companies such as DuPont, Exxon, and Inco have closely followed this lead, aided in part by the AIAA Corporate Associates program (established to help spark the interest of nonaerospace industries in the potential commercial returns on investments in space technology). TRW spearheaded an ad hoc Materials Processing in Space Industrial Committee consisting of U.S. Steel, Owens Illinois, Beckman Instruments, 3-M, and Merck, Sharp, & Dohm. Thus, even before the successful first flight of the space shuttle, a broad segment of private industry was becoming familiar with the prospects for industry in space.



Auspicious Beginnings

IN JANUARY 1981, a study conducted for the White House by the AIAA pinpointed

The weightlessness of space eliminates the need for containers, a major source of impurities and surface irregularities in manufacturing.

several examples of space-based processing of materials that could be comercially rewarding by the end of the century. Although 35 product-related opportunities could lead to significant levels of space manufacturing activities, 4 appear especially promising: pharmaceuticals, electronic devices, "specialty" glass and glass products, and advanced alloys.

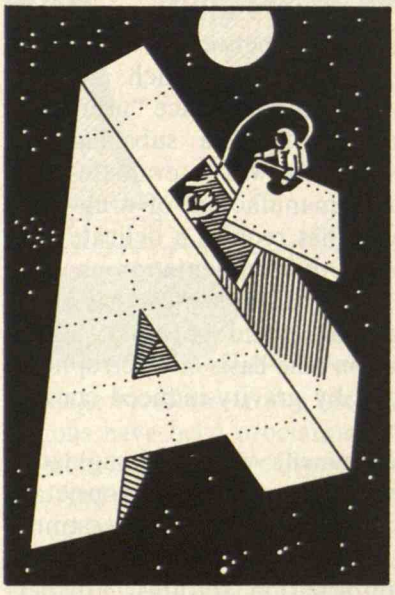
The electrophoresis experiments being conducted by McDonnell-Douglas for Ortho are designed to study commercial applications and potential market share. The first such experiment is scheduled to fly on the shuttle during 1982. If it is successful, commercial operation could begin by 1987. Such an operation would involve from five to twenty 20-chamber automated manufacturing plants and associated support equipment, depending on demand. The initial five plants would be launched at six-month intervals from the start of 1987 to the end of 1988, with additional facilities launched as required. Each facility would be a disc-shaped free-flying module, taking up approximately one meter in length of the shuttle's payload bay and weighing approximately 1600 kilograms. These facilities would likely share energy sources and communications systems and be placed in low-earth orbit, since they require frequent visits.

An average of four visits per year would be needed to collect the manufactured product and resupply the facility with raw material, which could be done for clustered plants in a single shuttle flight. Since the product would have a relatively small volume, most visits could be conducted on shuttle flights having other primary objectives. But the value of the manufactured product could be high enough to justify its own "dedicated" flight if the particular plant could not otherwise be visited. Depending on the success of the initial automated commercial operations and the availability of funds, future production could be conducted in a combined production-research facility on a manned platform.

The type of space facility needed to process each type of material will depend on its density and amount, as well as on the processes involved, support requirements, and the characteristics of the space transportation system. Some experimental processes may require advanced versions of the general-purpose materials-experiment carrier projected for the mid-1980s, especially if low-volume, high-value materials are involved. For others, a dedicated space facility may be cost-effective, particularly if the volume of the material is large or the process complex.

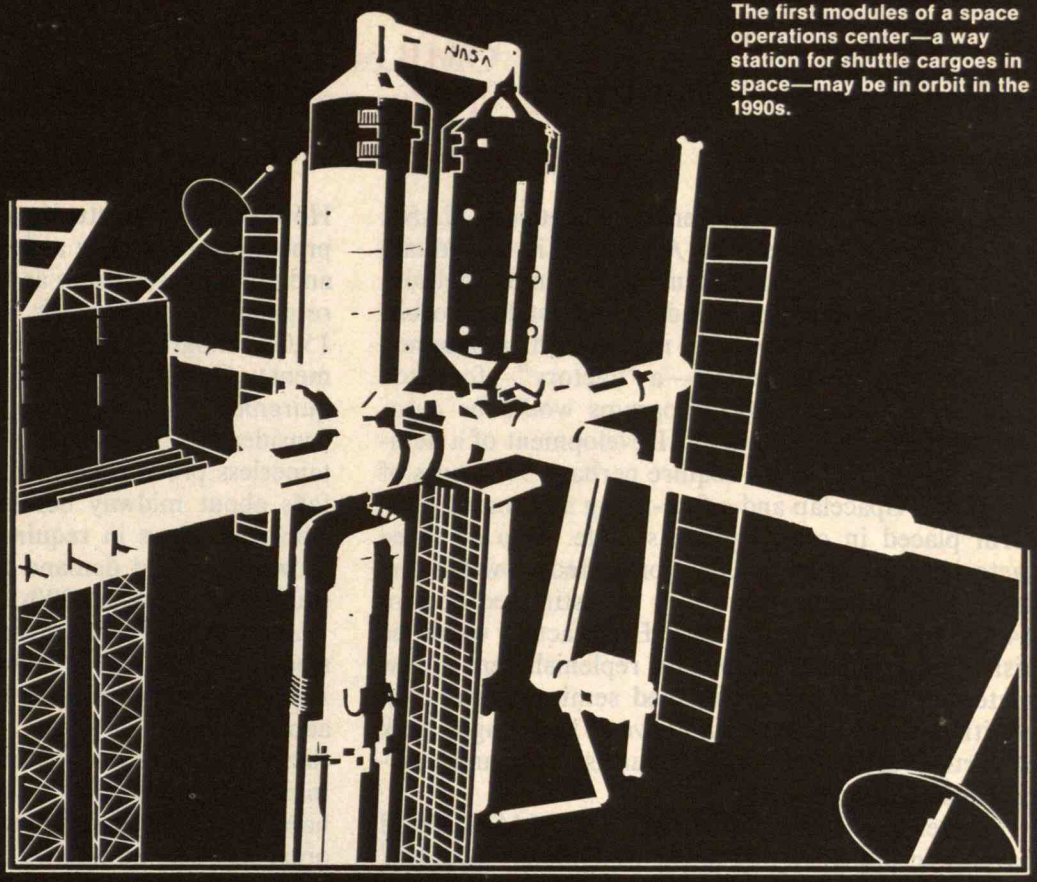
No other area of space processing has been developed as much as pharmaceuticals, and NASA is actively promoting additional R&D, but progress is limited by low levels of current funding—about $22 million in fiscal year 1981. (Funding for 1982, still undecided at this writing, will probably be lower.) A recent General Accounting Office report suggests that this is only one-half to one-third the proper level of funding, based on its assessment of European, Japanese, and Soviet activity. Support is likely to increase in 1983 if early experiments show signs of success, but NASA is limited to its traditional R&D role, which is bound to frustrate many private-sector users. In addition, some potential investors are still concerned about patent rights and other complications of joint federal-private ventures. The agreement between McDonnell-Douglas and NASA on the Ortho project eliminates many such problems by avoiding any exchange of funds, but it does require substantial private investment. But government incentives such as an R&D tax credit could profoundly enhance the attractiveness of these projects.

Sky-High Tech



AFTER pharmaceuticals, the major near-term market for space manufacturing involves electronic devices. This industry currently enjoys sales of about $16 billion per year, with a projected annual growth rate of 10 to 15 percent over the next ten years. As much as half this growth could come from space products. Like pharmaceuticals, electronic devices have an extremely high market value per unit of mass, manufacturing facilities are of modest size, and they can be highly automated so that total orbital mass is small even for high production rates. Moreover, production of electronic devices could be increased tenfold if the constituent materials are as homogeneous as space-based manufacture appears to promise.

A Spaceport for the Shuttle



The first modules of a space operations center—a way station for shuttle cargoes in space—may be in orbit in the 1990s.

WITHOUT a destination, the space shuttle is a little like an ocean liner on a "cruise to nowhere"—not a transportation system at all. Thus, NASA argues that the shuttle needs a destination, and the next major hardware project in the U.S. space program will be to give it one—a space operations center (SOC) that will receive and process materials from earth and deploy them in space.

As conceived by engineers at Boeing Aerospace and Hamilton-Standard, where most of NASA's SOC planning money has thus far been spent, the SOC would serve as:

☐ A base for experiments and experimenters that need more time in space than the shuttle allows.

☐ A construction base where parts of satellites and platforms delivered by several shuttle flights could be assembled, tested, and then deployed by orbital transfer vehicles (OTVs). This would include large (200-to-500-kilowatt) solar arrays and some preliminary work on the very large (100-meter) antennas projected for commercial satellite communications services in the 1990s.

☐ A base for a fleet of OTVs, manned and unmanned, that would carry goods from the SOC to their ultimate destinations in orbits higher than the shuttle can reach and service and collect data from free-flying satellites.

☐ A repair facility for satellites and their payloads, which could be retrieved and then returned to their stations by OTVs.

In one sense, the 20-ton Soviet space station, *Salyut 6*, occupied by many two-person crews from 1978 to 1981, represents a primitive prototype of the U.S. space operations center. The Soviets have made no bones about their intention to launch a multiperson (probably 12) orbiting space station by the mid 1980s, using their big new *Saturn-V* class expendable launch vehicle.

A Living Space and Refuge

The U.S. space operations center would be built in modules as parts were delivered by the shuttle; the first module—a service center with solar arrays, batteries, and propulsion equipment—might be completed in the early 1990s. Later would come two habitat modules for eight resident astronauts; their supplies and replacements would arrive every 90 days by shuttle. The astronauts in place, there could follow additional hardware—an operations center for the OTVs and an elaborate construction facility with mobile cherry-pickers and a turntable/tilttable for assembling large platforms and repairing satellites and equipment.

Many of the work stations and all living quarters would have pressurized environments, and the living quarters would be comfortable if not sumptuous so as to avoid "a feeling of being cooped up in space." There would be extra facilities so that the SOC could be a refuge, and the astronauts on board would be prepared to maintain "virtually all systems and subsystems" so that the SOC would have a minimum useful life of ten years.

Shipping 300 Tons into Space

Boeing and NASA argue that the SOC, the first U.S. "semipermanent" facility in space, will multiply by an order of magnitude the usefulness of the space shuttle. If their predictions are fulfilled, the first SOC will handle more than 30 OTV missions—at least 300 tons of cargo—annually by the year 2000, and by then the United States will be enthusiastically building a second one.

On the other hand, Jerry Grey of the American Institute of Aeronautics and Astronautics points out that some observers say the SOC is not in itself an economically supportable goal. Their thesis is that the bulk of commercial space activity in the next two decades will be in communications centered in geostationary orbit, far higher than either the shuttle or the SOC's vehicles could reach. Hence, developing the capability to build, orbit, and service multipurpose geostationary platforms would be far more important than the low-orbit SOC.

However, proponents of this so-called "geostar" are quick to admit that some form of SOC is probably an essential first step toward operations in geostationary orbit. In either case, the permanent presence of U.S. (as well as Soviet) people in space is almost certain to occur within this century.—*J.M.* ☐

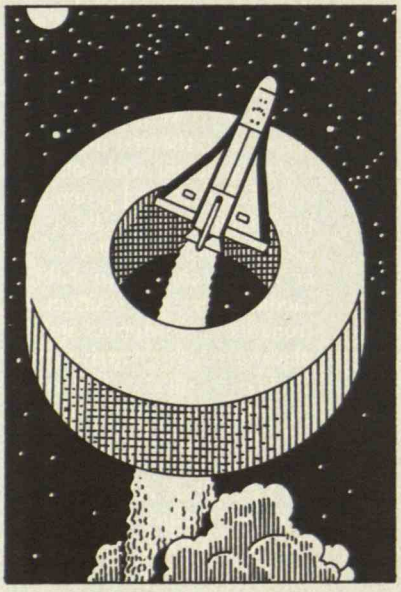
OMB essentially told NASA: "You've got $5 billion—take it or leave it."

The purpose of the joint endeavor between NASA and Microgravity Research Associates is to evaluate the growing of silicon, indium antimonide, gallium arsenide, and other semiconductor crystals in orbit. Such manufacture would require an unmanned 15,000-kilogram spacecraft—a "factory"—for each product, of which 5,000 kilograms would be automated processing equipment. Development of a demonstration model would require perhaps 500 hours of time from Spacelab and a free-flying automated platform placed in orbit by the shuttle. Two or three factories could satisfy half the projected growth in the U.S. semiconductor market at an estimated cost of $400-$500 million per factory. Each factory would be visited every 90 to 120 days for replenishment of raw material and pickup of finished semiconductors. In addition, the factories would have to be brought back to earth every few years for refurbishment and modernization.

Cooperation between industry and NASA would have to be similar to that of the McDonnell-Douglas/Ortho effort. A number of companies have already shown interest in pursuing this activity—materials manufacturers such as Monsanto and materials users such as Texas Instruments and Kevex. Companies such as TRW are interested in commercial products, space vehicle and payload development, and systems integration. Spacelab, and possibly the shuttle itself, would be adequate for initial studies in the early 1980s, but a longer-term free-flying space laboratory would be needed for the bulk of the 500-hour on-orbit development period. Such a laboratory, like that proposed as a commercial enterprise by Boeing, could be launched in the mid-1980s. Carriers of materials experiments and automated processing units could orbit and be serviced for 90 to 180 days. By 1990, a Spacelab-sized module—owned by a company, a consortium, or the government and fully dedicated to prototype development—might be needed, possibly as part of the proposed NASA space operations center (*see "A Spaceport for the Shuttle," page 41*).

The other two potential near-term areas for commercial space-processing operations—the manfacture of high-quality glass for optical, laser, and communications applications and advanced metallic alloys—are a bit further downstream. There is considerable interest in the advanced metal alloys by Inco, Kaiser, and U.S. Steel. One particularly attractive product is a highly corrosion-resistant nickel alloy that could replace zircalloy in nuclear reactor cooling systems and offer enormous potential return on investment. However, manufacturing would require an on-orbit processing capability at least three times as massive, and taking three times as long to develop, as the corresponding facility for electronic devices (about 15,000 kilograms and 1500 hours of on-orbit development). On-orbit assembly is therefore a likely requirement, raising the initial R&D and plant costs considerably. High-quality glass manufacture by containerless processing has similar cost constraints and falls about midway between electronic devices and advanced alloys in requirements for space facilities. However, broad demand for such glass may inspire such a scene in the 1990s.

A particularly interesting commercial prospect is small self-contained payloads—"getaway specials." According to Dr. Stanley I. Weiss, NASA's assistant administrator for space transportation operations, these can be flown for as little as $3,000 up to a maximum of $10,000. Over 300 getaway specials have now been committed: about half to industrial organizations, another 60 or so to educational institutions, and about 40 both to private individuals and other governmental agencies. Predictions of industrial activity based on results from these getaway specials are conjectural—they do not constitute enough payload mass even at double or triple the presently scheduled number to warrant inclusion in NASA's shuttle traffic manifest—but we estimate that from 2 to 10 percent will yield results of commercial interest.



Beyond *Columbia*

One key customer for the space shuttle's services has little interest in profits. The Department of Defense (DOD) requires only that the shuttle is suitable to service defense satellites and that launch schedules are adhered to. As both a major investor in the shuttle (in launch facilities and auxiliaries) and a major user (more than a third of projected launches), the military has exerted a strong influence in shaping its design and opera-

A bird watcher's guide to Amoco's environmental efforts.

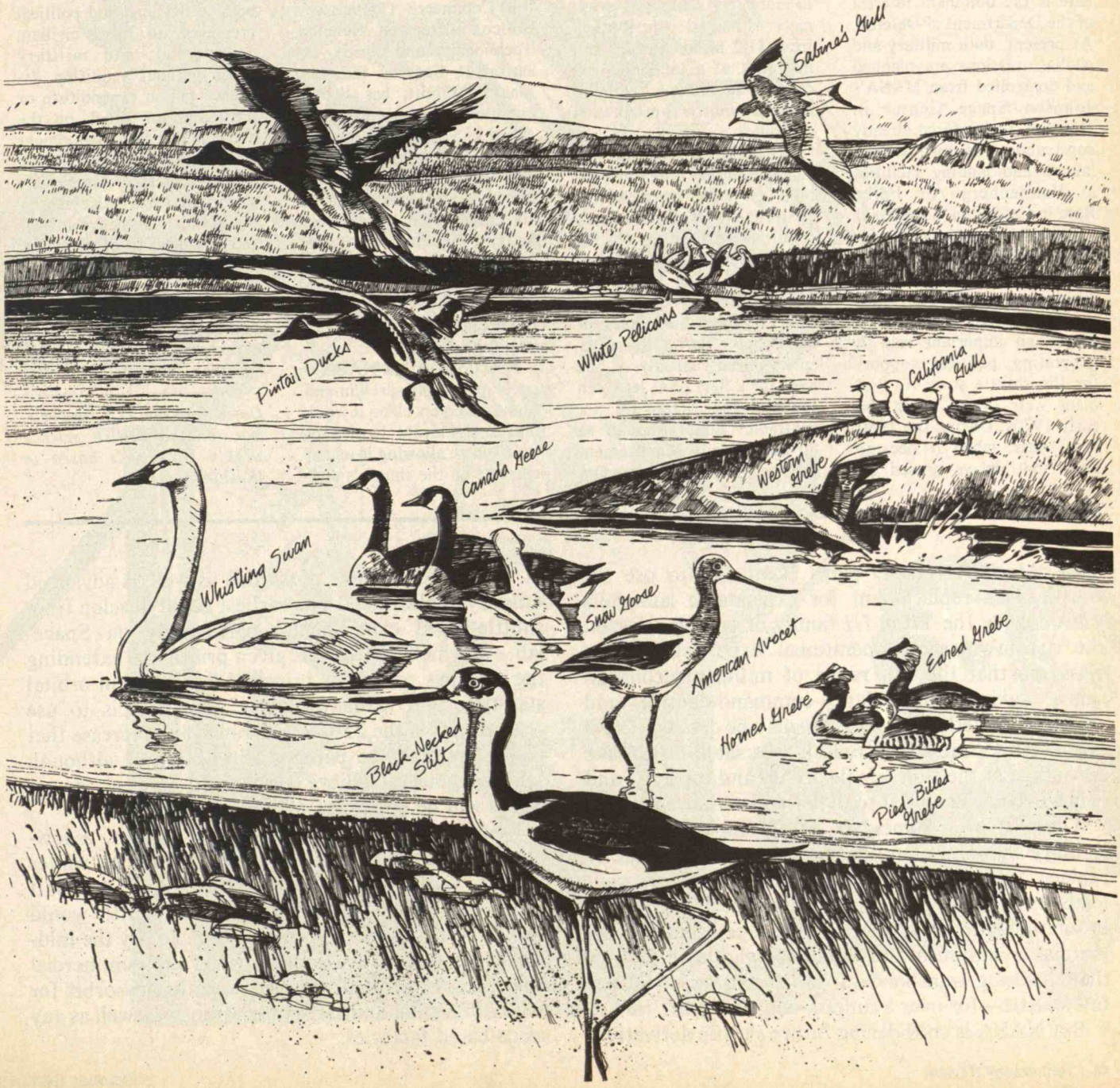


The harmonious coexistence of the energy industry and the natural environment is being proved at Amoco's Casper, Wyoming refinery. Biological management has turned a waste water pond into the state's most prolific habitat for birds and other wildlife. The refinery's fresh water effluent has decreased the pond's alkali content from 20,000 parts per million to 7,000. This remarkable improvement in water quality has created an ecosystem that supports more ducks and geese than anywhere else in the state.

The Audubon Society monitors the pond and now catalogues a wide variety of bird species—including grebes, geese, eagles, swans, and the rare Sabine's Gull—not found in the area before construction of Amoco's refinery.

This Wyoming wildlife habitat is a real example of how Amoco can supply energy to help meet America's needs while preserving the environment.

You expect more from a leader.



The View from Washington

by David Dickson

COLUMBIA's maiden flight in April showed that NASA had successfully resolved many technical challenges. But the future of the shuttle is clouded by political uncertainties—concerning the appropriate size, shape, and direction of the U.S. space effort—that are unlikely to be resolved as neatly.

Central to the current debate is the dominant interest of the Department of Defense. At present, both military and civilian missions are planned and controlled from NASA's Johnson Space Center in Houston. The air force, already constructing its own shuttle launch and landing facilities at Vandenberg Air Force Base in California, now says it also needs its own control center for security reasons.

There is unlikely to be strong opposition. The space ambitions of DOD have played an important role in generating political support for the shuttle since its first plans were drawn up in the early 1970s. During the 1980 fiscal year, when it became clear that delays caused by technical difficulties were going to raise costs significantly, Congress increased the shuttle's budget by $220 million, primarily to keep critical defense missions on schedule. And the military drew on its own funds as well. A report published this spring by the General Accounting Office (the investigatory arm of Congress) revealed that DOD had to more than double its originally estimated contribution, from $1.2 billion to $2.8 billion (out of a total now exceeding $8 billion), to maintain the shuttle's production schedule.

Enthusiasm for an enhanced shuttle program runs high in some congressional quarters. At Dr. Hans Mark's confirmation hearings (to become deputy administrator of NASA) in June before the Senate Commerce, Science, and Transportation Committee, Senator Barry Goldwater spoke enthusiastically of the need for a fleet of at least ten shuttles. Dr. Mark did not contradict him, although so far the Office of Management and the Budget has been more skeptical. At present only four orbiters are under construction, with options held by NASA on a fifth. Dr. Mark told the committee that an expanded number of orbiters would reduce production costs as well as help resolve tensions between civilian and military users.

Some politicians would like to go further. The chairman of the Commerce Committee's Subcommittee on Science, Technology, and Space, ex-astronaut Senator Harrison (Jack) Schmitt, has already endorsed proposals for a so-called U.S. Space Command. This would expand the current Air Force Space Division into an operational agency for all three military services. Schmitt says there is a "clear necessity for a public shuttle fleet and a defense fleet—one operated by NASA or a NASA spin-off and one operated for defense."

Reactions within NASA to such proposals are mixed. Some observers claim it would take a significant burden off the agency, allowing it to concentrate on the shuttle's civilian and commercial applications. But with further budget cuts looming on the horizon, others argue that the civilian program—including NASA's various space science missions—will be more secure if it remains under the wing of the military.

The Reagan administration is currently trying to forge a space policy that is responsive both to financial and political pressures: to meet civilian, commercial, and military needs without requiring excessive public expenditure or infringing too much on the doctrine that the development of commercial technology should be left to the private sector. Dr. George Keyworth, the president's science advisor and new director of the Office of Science and Technology Policy, has been given the task of developing guidelines for such a policy. His report is expected within the next few months. □

David Dickson, U.S. news editor for the British science weekly Nature, *is based in Washington, D.C.*

tions. Moreover, DOD plans eventually to use the shuttle as a replacement for expendable launchers (particularly the *Titan III* family of launch vehicles, the nation's largest operational expendable-rocket class) so that the full range of military reconnaissance, navigation, guidance-command-control, and intelligence-gathering satellites may be orbited. DOD began some time ago to redesign its satellites to take advantage of the shuttle's flexibility and capacity, and it has become essential to defense plans for space.

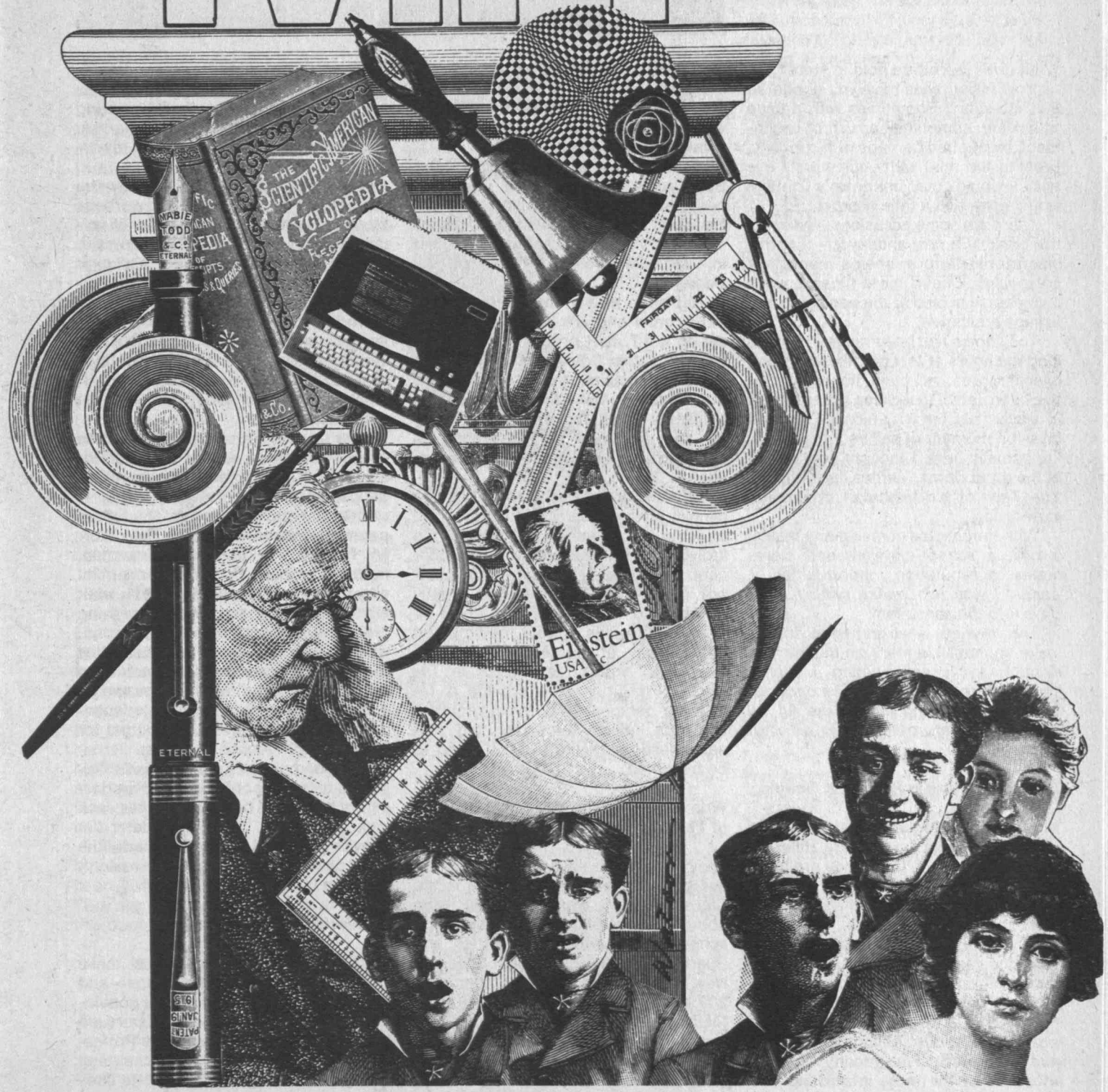
There is even some talk of developing a wholly military shuttle system that would either duplicate or replace NASA's. In the latter case, nonmilitary payloads would have to beg rides into space. This would be anathema to heavy users such as operators of commercial communications satellites, who lease each of their orbiting transponders—on the order of 60 per full shuttle—for over a million dollars a year.

But NASA is considering future shuttle derivatives of its own for a range of civilian as well as advanced military applications. The earliest could develop from shuttle-based experiments—particularly on Spacelab—in which NASA has given priority to extending the shuttle's power, its principal limitation in orbital stay-time and maneuverability. The goal is to use solar panels in the 25-kilowatt range and increase that power gradually to perhaps 250 kilowatts, although some engineers believe that small nuclear power plants will be more cost-effective at that level.

NASA's most likely next major project, a low-orbit, permanently manned space operations center (SOC), would utilize the shuttle and 25-kilowatt power modules for its construction; the shuttle would also serve as the SOC's resupply vehicle. By the mid-1980s, such a center could service the commercial aspects of large platforms in geostationary orbit for communications and earth observations, as well as any space-based factories.

MIT

Freshmen arrive once again, in general confusion, to bring new talent, enthusiasm, and diversity. They come from everywhere and bring every kind of interest . . . page A2, A3.
(Illustration: Karen Watson)



Freshmen: A Beginning

"I felt like Alice in an M.I.T. Wonderland: bewildered, baffled and fascinated."



What does the future hold in store?

How many times have you pondered that question? Sometimes with a tinge of anxiety, sometimes a rush of excitement, most often perhaps with curiosity, probing the mist with your mind's eye and wishing the unknown's outline would grow just a little sharper.

There are some occasions—when on the brink of a new endeavor—that this inscrutable future seems especially compelling. One of these times is when a student is poised at the beginning of a college education.

The choice has been made. However long the hours of thought, the agonizing over the pros and cons, however positive or tentative a decision it was, now it is reality. "At the R/O picnic, I allowed myself a moment of self congratulation. I'm actually here, I thought, looking up at the great dome," writes Jack Link, in *The Tech* of his freshman orientation experience.

With that choice comes many facets: a city, a school environment, classmates, a reputation, opportunities, a *pace. "I was two weeks behind three days into the semester."*

The myriad environmental inputs make an indellible mark on the impressionable freshman; molding, influencing, prodding him or her. *"The opportunities to do anything are endless. All you need is the get-up-and-go to do what you want."*

The Most Valuable Resource: People

They are each unique individuals, to cull different benefits and create different difficulties at M.I.T. Once they are here, they go in many ways, absorb different influences, sometimes switch radically from their original paths. They can learn, above all, from each other and from the community. "M.I.T.'s most abundant educational resource is its people," writes Stephanie Pollack, '82, in *The Tech.* "The M.I.T. community—a loosely-knit group encompassing the students, staff, and faculty—constitutes one of the most interesting and varied groups of people to be found anywhere. While exposure to this melting pot of Nobel laureates and high school computer hackers may not be worth $12,000 [times four], it is certainly a valuable experience."

Some adopt a cynical edge after three years. "After a while, sleeplessness, educational frustration, and unbalanced social patterns take their toll and a pervasive cynicism seems to set in," writes Ms. Pollack in this issue (*see page A3*).

But often loyalty and admiration for M.I.T. grow and are nurtured. "What I see in M.I.T. as I prepare to leave it," wrote Stephen Solnick, '81, "is not, as some people think, a cruel, ivory-tower, academic sweatshop. I see instead a university populated with brilliant people and an almost unlimited potential for learning, enjoyment, and experience."

Whether or not freshman do become cynical after a steady diet of the grind undoubtedly depends entirely on the individual. The newcomers are all innocent, and all ready to begin—they know not quite what. Their input is greatly appreciated. "Many activities would be in serious trouble without the time and enthusiasm of numerous freshmen members," writes Ms. Pollack in *The Tech.* "Freshmen also provide a refreshing perspective to living groups," she adds. Indeed, she wrote, "the most enthusiastic students at M.I.T. tend to be freshmen . . ."

Who Are They and What Will Become of Them?

They come from everywhere and bring every kind of interest. Students in the Class of 1985 were accepted from about 850 public and private high schools in 45 states, 27 countries, and Puerto Rico. Stuyvesant High School in New York sent the largest number; over 200 are from New York, 117 are from Massachusetts, and 74 are from California. The 1,060 students in the entering class is only 10 students more than the class target of 1,050 set by the Academic Council last February.

Some of their hobbies: sheep breeding, toymaking, marquetry, tiddlywinks, breeding rare birds, figure skating (USFSA silver medalist), filmmaking, choreographing Chinese Opera, fly-tying . . .

They have been lured here by the reputation that is M.I.T.'s, and perhaps by contact with Educational Council volunteers who are available to meet with interested prospective students all over the world. Once they get here, the 12-day R/O week period coordinated by Rhonda Peck, '82, is packed with activities from the sublime to the serious: ice cream parties, treasure hunts, meetings with faculty advisors, off-campus expeditions, a time to choose a living arrangement.

The decision of where to live looms large. Fraternities noisily clammor for attention. "The human environment, or people aspect, of fraternity living is clearly the most important factor as potential members evaluate the different houses," writes Steve Immerman, fraternity advisor. But other items must play a part in the decision. "First: what are the purposes and aims of the living group? What does it stand for? Second, what specific duties or responsibilities are freshmen residents expected to comply with? Third: what are the specific costs involved in living in an independent living group? What do you get for your money?" Advice abounds.

Yet good choices can be made flippantly, too. "I eventually picked my dormitory by the flip of a coin," writes Jack Link in he Tech. "Two years later I'm convinced that I somehow made the best possible choice, and I wouldn't consider living anywhere else."

Admissions Office Dilemmas

M.I.T. admissions must entice these students to come in the first place—and the thin slice of the high school population they are after is also hotly pursued by the ivy league colleges, says Professor Frederick J. McGarry, '50, chairman of the Admissions Committee. He cites the ivy league as one of three big obsta-

The largest number of women ever in a freshman class enrolled this fall. Waiting for assistance with her luggage is Lori Cantu of San Antonio, Texas, one of 258 women among 1,050 freshmen. (Photo: Calvin Campbell)

cles faced by the admissions office. "In nine families out of ten," he suggests, "my guess is if Johnny is admitted to M.I.T., Yale, Princeton, and Stanford—nine out of ten won't come to M.I.T. In some respects the ivys are classical universities, with all that implies; by the same token very few educational institutions in the world can offer the depth and breadth of technical education that this place can."

But that same technical excellence fosters the second problem: image. Unfortunately M.I.T. is frequently imagined as a body politic with everyone in locked step, a monolithic mass totally preoccupied with technology and the sciences. "On one hand, a large percent *is* engineering and science; on the other, there is tremendous variety and opportunity here, such as research with faculty and graduate students," says Professor McGarry. "Yet the image persists of a factory with the same gingerbread cutouts, four or five raisins down their coats, all alike."

The third difficulty: crass old money. "Something over half of the undergraduate population receives financial aid (it can be in the form of work/study). For every dollar of tuition we have to raise three dollars to pay the real cost, and that is harder and harder, Professor McGarry explains. An important part of the undergraduate process is the Student Financial Aid Office. "For decades, M.I.T. has boasted that no youngster academically qualified will be kept out for lack of money. And they do it, magically," he says.

Those students who passed the intensive scrutiny of admissions have been invited, and some answered yes. They are here, now, to profit or not from this opportunity.—*M.L.*

Bring in the New: Talent, Diversity and Enthusiasm

By Stephanie Pollack, '82



M.I.T. upperclassmen are far from a homogeneous group. Still, there are certain qualities which are common to a great number of those who have done time at the Institute. After a while, sleeplessness, educational frustration, and unbalanced social patterns take their toll and a pervasive cynicism seems to set in. Luckily, the same cycle which burns out the old brings in the new.

The annual Labor Day infusion of freshmen provides many of the needed ingredients for the continuation of life and education at the Institute. The valuable experience and perspective lost with the departure of the graduates at the beginning of the summer cannot be competely replaced. Instead of filling that gap, the talent, diversity, and enthusiasm of the incoming class strengthen other parts of Institute life, insuring change as well as continuity. This cycle repeats itself without imposing any specified responsibilities on individual members of the freshmen class, and often without the conscious participation of the class as a whole.

Newcomers are burdened with a host of other responsibilities, however. While freshmen ask only that M.I.T. provide them with an education and a place to grow, M.I.T. asks much more of the freshmen. They must acquire the rudiments of a technical education, adjust to what may be radically different living conditions, replenish the depleted ranks of student activities and government, and blend themselves into the M.I.T. community.

Freshmen are thus as important to M.I.T. as M.I.T. is to freshmen. Realizing this, the Admissions Office conducts careful evaluations to find freshmen equal to the challenge. The admissions process must be a search for more than academic talent if any balance is to be struck between the educational and social functions of the Institute. The Admissions Office has generally been successful in selecting students capable of getting more out of M.I.T. than A's.

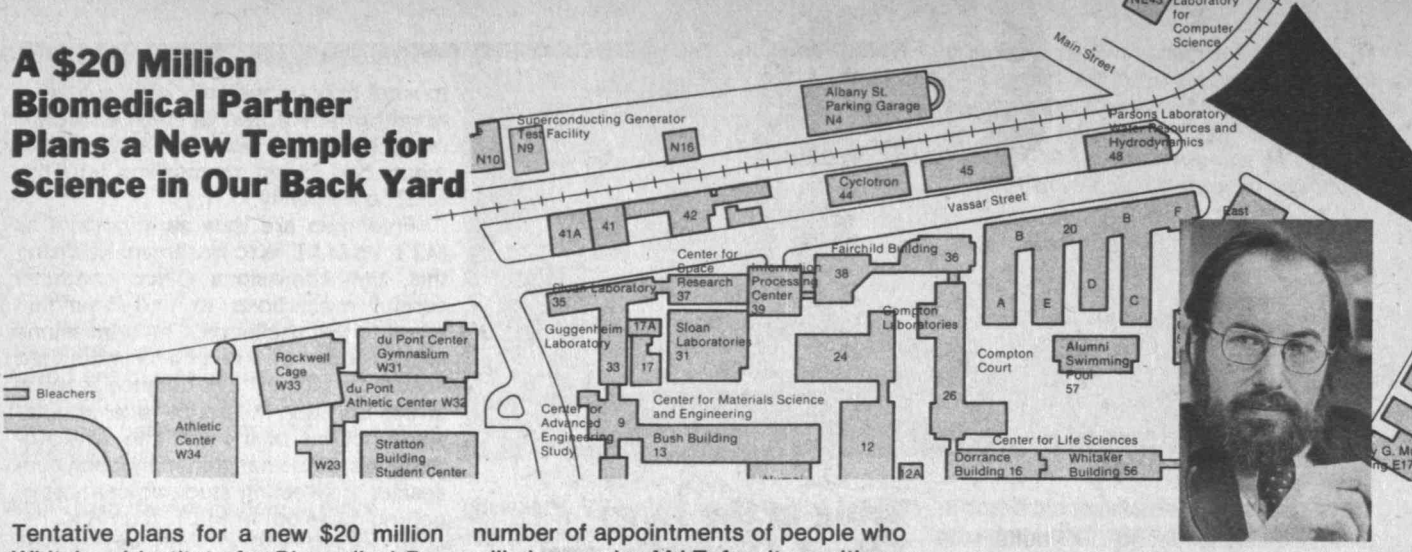
In recent years, however, upperclassmen have complained that the freshmen are more conservative and studious—a euphemism for nerdly—and some have accused Admissions of downplaying the importance of personal factors in the applications process. A policy of this type, common at many graduate schools, is certainly easier to follow than one of attempting to rank applicants on qualitative criteria. Adopting such a change in policy, while pragmatic, would be foolish and injurious to the health of the student body.

In spite of doubts about the group personality of the incoming class, all but the most terminally hardened upperclassmen will greet the freshmen with honest friendliness. While Rush is just that, there is ample time during Residence/Orientation Week for new and old students to mix and learn. At least some of the upperclassmen sense the need for the influx of diversity and optimism, and so welcome the turnover as heartily as the individual freshmen.

Perhaps those who first came to the Institute before the new freshmen were born are by now bored and feel nothing more than *deja vu* watching the newcomers' reaction to Freshman Picnic. Those whose role in the cycle is still that of undergraduate, however, are significantly more elated at the arrival of the freshmen. We will grin at their naievete and feign exasperation at their ignorance. Cynical burn-outs that we be, we know that a few months of being crammed into 26-100 and fed identical and equally meaningless equations will homogenize the class in many ways. Nevertheless, during the early weeks of the fall, while the freshmen are still getting lost whenever they leave the Infinite Corridor, our attitude can only be one of friendliness and encouragement.

Stephania Pollack is a senior studying mechanical engineering and public policy. She expects to go law school in 1982.

A $20 Million Biomedical Partner Plans a New Temple for Science in Our Back Yard



Tentative plans for a new $20 million Whitehead Institute for Biomedical Research—Richard A. Knox of the *Boston Globe* calls it nothing less than "science's new Taj Mahal"—to be located adjacent to M.I.T. were announced during the summer by Edwin C. Whitehead, founder of Technicon Corp. who is believed to hold one of the nation's largest personal fortunes.

The new Institute's director is to be Nobel laureate David Baltimore, American Cancer Society Professor of Microbiology at M.I.T., and it will have many close ties to M.I.T.—an interrelationship "unique among universities in the U.S.," says Professor Francis E. Low, provost. Legal documents defining that relationship were drawn up during the summer and are scheduled for approval by the M.I.T. Corporation at its annual meeting on October 2.

The Whitehead Institute announcement attracted unusual interest because of its unique stipulations involving M.I.T., because of the immense financial resources involved, and because of Mr. Whitehead's previous relationships with educational institutions.

Joint Appointments and Graduate Students

Writing to his faculty colleagues last summer, Professor Low reported Mr. Whitehead's concern that his new institution have "a close relationship with a university having a strong educational and research program in the life sciences." Accordingly, the relationship proposed between M.I.T. and the Whitehead Institute includes, according to Professor Low:

☐ The Whitehead Institute will be governed by its own board, on which M.I.T. will have minority representation.

☐ The director of the Whitehead Institute will be an M.I.T. professor, appointed by the Whitehead Institute's board and approved by M.I.T.; the director will sit on the Whitehead Institute's board.

☐ The Whitehead Institute will make a number of appointments of people who will also receive M.I.T. faculty positions; the mechanism for such M.I.T. appointments will be identical to the usual one—search procedure followed by approvals, in turn, of the relevant school council, the Academic Council, and the Executive Committee of the Corporation. The full salary of these appointees will be paid by the Whitehead Institute; the salary level will be approved in each case by M.I.T. in the usual way so as to achieve salary equity between the two institutions.

☐ The total number of such faculty appointments foreseen is about 20, both tenured and nontenured. At least in the beginning, the M.I.T. appointments will be in the Department of Biology, though appointments may be made in other departments.

☐ Additional graduate students will be admitted by M.I.T. in response to the presence of the new professors. These graduate students will be supported by the Whitehead Institute either directly or through sponsored research.

M.I.T. has much to gain from the Whitehead Institute, Professor Low said in his letter to the faculty—a larger intellectual community (the Whitehead Institute will be built on redevelopment land adjacent to Technology Square, across from the Parsons Hydrodynamics Laboratory), more student and faculty resources, and an outright $7.5 million grant from Mr. Whitehead to offset "financial and intellectual costs, most of which are hard to predict precisely," Professor Low says, which may be associated with founding the new relationship. The funds will be used for a new full professorship and a career development professorship and to support other activities "in departments and centers that become involved in joint activities with the Whitehead Institute," Professor Low promised.

Worry Is Reasonable—but Not Too Much

Mr. Whitehead's Technicon Corp. began in 1939 in a loft in the Bronx, where with $5,000 of borrowed capital he and his father made a machine to automatically analyze tissue samples taken during surgery. Eighteen years later, by then the sole owner of his company, Mr. Whitehead bought patents on a second outstandingly successful bioengineering innovation—a machine to automatically analyze blood samples.

By 1969, when Technicon went public, Mr. Whitehead was still its sole stockholder, and he became—on paper, at least—worth more than $1 billion. Ten years later the company was sold to Revlon for nearly $400 million in Revlon stock and cash. Since then Mr. Whitehead has been vice chairman of Revlon, but he has spent much of his time looking for a way to "repay his debt to modern medicine," Mr. Knox said. Indeed, Mr. Whitehead told Mr. Knox that estabishment of his institute has been "the most important thing in my life, my number-one priority."

Of many institutions considered for the Whitehead Institute, the first successful contender was Duke University, where plans for a research staff of 100 devoted to seeking "definitive solutions" to major human diseases were announced in 1974. No one will say why these plans fell apart; most rumors suggest that the problem was Mr. Whitehead's determination to exert personal control over its programs.

On this issue, Professor Baltimore remains unconcerned. Mr. Whitehead's is "the most extraordinary gift to biomedical research ever made," he told Mr. Knox. And Professor-Emeritus Salvador Luria, director of the M.I.T. Center for Cancer Research, put it this way to Mr. Knox: "There are two kinds of feelings when people get married—the excitement of marrying the woman you love and the fear that she may turn into a shrew. Some of the worries are reasonable and logical, but you shouldn't worry so much that you don't get married at all."



The UFO Question Lands at M.I.T.

What do scientists and UFO buffs have in common? A fascination for the unexplained. But often that is where it ends.

Without supportable evidence to back up reports of little green men and glowing discs that go bump in the night, most of us soon part company with most UFOers.

To the latter that response is both short-sighted and frustrating, and—hoping to establish a better professional image—the Mutual UFO Network, Inc. (MUFON), a civilian, non-profit organization dedicated to the scientific study of UFOs, chose to hold its 12th annual symposium at M.I.T. last July 25 and 26 for an audience of some 300.

"To have a symposium on unidentified flying objects at the prestigious technical facility of the Massachusetts Institute of Technology proves that the science of UFOs is earning its position in the community," said Walter Andrus, international director of MUFON, as he opened the program. Most of the speakers—Ph.D.s in sociology, astronomy, psychology, and theology—fulfilled Mr. Andrus' objectives. But the fringe giving testimony of supposed abductions, for example, was not to be rejected.

The dominant theme of the conference, expressed by most of the speakers, was the desire to be taken seriously. Investigators of the UFO phenomenon must adopt a professional attitude, said J. Allen Hynek, scientific director of the Center for UFO Studies. Dr. Hynek stressed that the UFO phenomenon has been heretofore misrepresented to the public and to science alike. "We must face up to it," he said. "Ufology is today what chemistry was when it was alchemy—a grand assortment of superstitions, beliefs, and wishful thinking. But eventually the science of chemistry evolved out of the alchemical mess." He is convinced that support for serious research will come from the world at large once ufology establishes a stature of credibility.

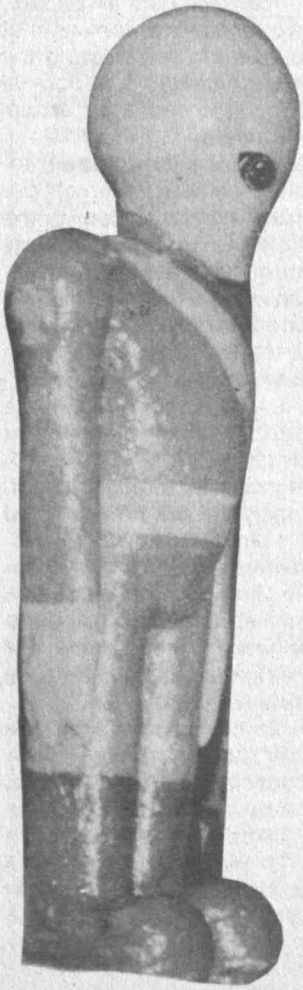
Peter Gersten, an attorney who has represented Citizens Against UFO Secrecy in suits against the Central Intelligence Agency and the National Security Agency was on hand to insist that a substantial amount of expert testimony on the existence of UFOs by responsible people—scientists, military personnel, law enforcement officers—remains locked up in classified government documents. He challenges the classification of many of these, claiming the public's right to known under the federal Freedom of Information Act.

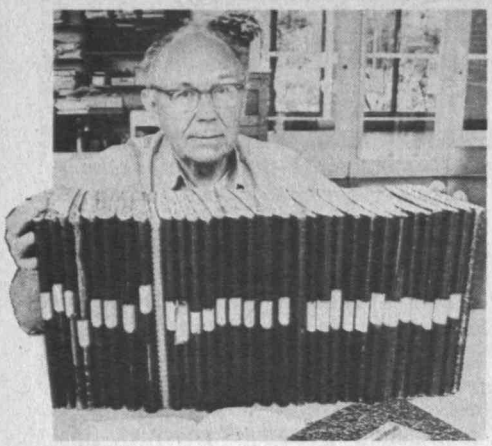
Ted R. Phillips, an inspector for the Missouri State Highway Department, who was introduced as the world expert on physical traces found at alleged UFO landing sites, reported that he has personally investigated more than 300 UFO reports—taking testimony, soil samples, measurements, and photographs at the site—and has compiled a file on physical traces containing some 2,000 reports from 64 countries. Most of the objects are reported to be circular in shape, metallic or orange-red in color, to move with little or no sound, and to ascend and descend vertically at very high speeds. They have been seen under all kinds of atmospheric conditions, Mr. Phillips said.

A Soviet analysis of 256 sightings published in February, 1981, by the U.S.S.R. Academy of Sciences Institute of Space Research takes an equally serious, statistical approach, said Mr. Phillips. Most of the Soviet sightings were in the evening hours, most frequently around 9 p.m., which coincides with Mr. Phillips' trace cases. Soviet observations lasted an average of one to four minutes; Mr. Phillips' lasted one to five minutes. According to the Soviet data, 66 percent of the sightings were witnessed by more than one observer, and 52 percent of the observers were scientists, engineers, or pilots.

Why such a conference at M.I.T.? When asked why he agreed to act as faculty sponsor for the event, Charles Stark Draper, professor emeritus of aeronautics and astronautics, replied, "Because they asked me." He claims an open mind on the subject and believes that everyone should be given a chance to talk—that MUFON members should be allowed to state their case without anyone deciding beforehand whether their information is important or not.—*S.K.*

Photos: Dennis Stacy





"July 16, 1935—Yesterday took baseball picture. Henry Dunderdale from the carpentry shop did the hitting. Apparently a baseball does not compress like a golf ball." *Just one entry among thousands in the laboratory notebooks of Professor-Emeritus Harold E. Edgerton, Sc.D.'31, which he has now given to the Institute Archives. The 33 volumes illuminate 45 years of his life and times in a style that only belongs to "Doc"—"one can trace not only his major technical contributions but also his life," says Helen Slotkin, director of the Archives. There are no restrictions on the gift, and "Doc's" notebooks are available to anyone who registers at the Archives and wants to see them. (Photo: Calvin Campbell)*

Science Looking for a New Dean

After more than 14 years as dean of the School of Science, Robert A. Alberty wants to return to teaching and research in chemistry, a field in which he was active before taking on administrative duties at the University of Wisconsin—where he was dean of the Graduate School—in 1963. He'll make the move from the dean's office as soon as a successor is chosen.

Responding to the announcement, Professor Francis E. Low, provost, said Dean Alberty's tenure had been characterized by "generosity of spirit and devotion. . . . His many contributions as a scientist, administrator, and fellow human have enhanced the stature and well-being of all in the School of Science and the Institute as a whole."

In addition to his responsibilities as dean, Professor Alberty has chaired the Institute's Council on Environmental Health and Safety; and he has also been chairman of the so-called "core group"—the 20 faculty members who teach freshman science subjects, meeting periodically with members of the dean's office.

Campus Trespassers vs. Freedom of Speech

Chris Schmid was arrested in 1978 for trespassing on the Princeton University campus; a member of the U.S. Labor Party, he was distributing political leaflets without Princeton's permission. Later that year the New Jersey Supreme Court overturned Schmid's trespassing conviction, ruling his arrest a violation of his freedom of speech.

Now Princeton has appealed the case to the U.S. Supreme Court, proposing that restricting access to the campus is a matter of "educational philosophy" and the university's academic freedom. And M.I.T. has joined the cause by filing a friend-of-the-court brief, saying that the New Jersey decision "represents an unwarranted judicial intrusion into the field of educational policymaking. As such, the decision strikes at one of the most substantial elements in the bundle of rights held by a private university in its campus property."

A crucial element in maintaining an environment conducive to learning, the M.I.T. brief said, lies in the ability of a university to regulate access to that environment "and to limit participation in it to those whom it selects . . . The 'right to exclude others' where they threaten to interfere with the educational purposes of the university thus constitutes an essential componenent of the value or utility of the university's private property . . ."

Though its campus is open, the brief said, M.I.T. "extends no open-ended invitation to the public to come onto the campus or to use M.I.T. facilities at will."

A Strike Threat as the Students Return

As this issue of *Technology Review* went to press, the Institute's smooth transition from the quiescence of summer to the bustle of fall was jeopardized by the threat of a strike by food service employees.

A "wide range of issues" separated the demands of the union and the offers of the Institute, James J. Culliton, director of personnel, told *The Tech*; and Domenic Bozzotto, president and business manager of Local 26 of the Hotel, Restaurant, Institutional Employees, and Bartenders Union (AFL-CIO) said its Executive Board had authorized a strike if negotiations broke down. The previous three-year contract has expired on June 30.

Special Assistant for the Arts

Professor William L. Porter, Ph.D.'69, who retired as dean of the School of Architecture and Planning on September 1, already has a new job: special assistant to the president for the arts. His assignment: to foster faculty participation in the Institute's arts programs and provide liaison between the faculty and the Council for the Arts at M.I.T.

As special assistant, Professor Porter succeeds Professor-Emeritus Roy Lamson, who held the post from 1971 until this fall. Professor Lamson's involvement will continue as secretary to the Council and a member of its Executive Committee.

The Bursar's Office Reopens

After a six-year hiatus, M.I.T. has a bursar again—Arthur R. Wagman, formerly assistant superintendent for business administration in the Wayland (Mass.) Public Schools. His office is responsible for billing and collecting student charges, loans to students, parents, and former students, and loans for faculty and staff children—total financial commitments of over $100 million annually. The idea, says Jack H. Frailey, '44, director of student financial services, is to centralize and simplify relations between M.I.T. and its financial clients in a time when "the process of paying for a college education has become increasingly complex."

Business as Usual After 100,000 Megawatt-Hours

One of the Institute's most versatile facilities achieved a major milestone late last spring: the Research Reactor logged its 100,000th megawatt-hour of energy output. The precise moment—4:15 a.m. on April 30—was observed in a manner consistent with the way the reactor has been operated since 1958: nothing out of the ordinary happened. It was business as usual.

Research projects using the reactor at the time included neutron scattering studies, analysis of rocks and minerals, studies of human nutrition, brain cancer and arthritis therapy research, trace element detection in sea water, computer applications to reactors, health effects of coal utilization, and the development of durable materials for fusion reactors. Following reconstruction in 1976, the reactor has been operated normally at a level of 5 megawatts with its temperature slightly below the boiling point of water.



An Exultant Report of a $7.2 Million Alumni Fund for 1981

Over 24,600 alumni gave over $7.2 million to the Alumni Fund in 1980-81 on its 40th anniversary. They set new records in the number of donors, the number of first-time donors, the number of gifts of $100 and more, and the total support of the Institute—"a signal year," said Christian J. Matthew, '43, in his report as retiring chairman of the Alumni Fund Board.

It was the eighth consecutive year in which the Alumni Fund had set a new record for total giving and the third year in a row that it had advanced to a new million-dollar plateau, said Mr. Matthew: $5.16 million in 1978-79, $6.23 million in 1979-80, and now $7,287,000. That represents a 47-percent increase in three years, far exceeding inflation—"a remarkable demonstration of commitment to the Institute by its alumni," Mr. Matthew said in an exultant report to Paul E. Gray, '54, president of the Institute.

Dr. Gray called it "splendid news . . . most welcome," a demonstration that "the alumni of M.I.T. are willing to do their share to preserve the high quality of this special place."

It was the third consecutive year in which participation in the fund had increased—from 21,891 in 1978-79 to 24,644 in 1980-81. Of the 1980-81 participants, 1,900 were first-time givers, exceeding last year's record total by more than 400. Among the five youngest classes, 862 alumni made their first gifts to the fund.

Nearly one-quarter of all gifts to the fund were for $100 or more—a 44-percent increase in three years. And by making gifts of $250 or more, 1,373 alumni qualified as charter members of the Great Dome Associates (*see page A8*).

The 1980-81 total included $3 million in unrestricted gifts, up $300,000 from one year ago; these, especially, President Gray told Mr. Matthew, "underwrite in the most helpful and flexible way the basic academic strength of the Institute."

The record results were made possible, Mr. Matthew said, by the efforts of some 1,500 alumni and student volunteers who made solicitation visits and telephone calls. More than 400 alumni were reached in person by other alumni; 70 percent of these made a gift to M.I.T., and the average gift was $340—a 91-percent increase over the average gift of the same alumni in the previous year. Telephone solicitation programs were an "overwhelming success," says Joseph S. Collins, director of the Alumni Fund: more than 750 alumni and students called more than 13,000 alumni from Cambridge and many locations throughout the U.S. and Canada. On average, each caller raised $448—up from $385 raised by telethon participants in 1979-80.

Members of the Alumni Fund Board were not present when President Paul E. Gray, '54 (behind him, above: Joseph S. Collins, director of the fund) led a mid-summer celebration. But the fund's 1981 records were apparent when the board posed at its June meeting (below). Left to right: seated—Allan S. Bufferd, '59, Joseph Byrne, Sc.D.'50, Joe F. Moore, '52, Christian J. Matthew, '43 (chairman), Peter P. Gil, Harl P. Aldrich, '47, and Carol A. Catalano, '77; standing—John K. Gohagan, Ph.D. '73, E. Martin Davidoff, '74, Robert W. Mann, '50, Floyd A. Lyon, '42, Clyde N. Baker, '52, Jack W. Christensen, '58, Emily Wade, '45, Rutherford B. Harris, '37, Jamie C. Chapman, Ph.D. '66, Irwin W. Sizer, William J. Hecht, '61, Thomas H. Farquhar, '60, and Raymond H. Danon, '58.



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Product Safety/Safety Analysis
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Irvine, CA 92713
(714) 752-1330

Great Dome Associates

1,350 in the First Year

The honor of charter membership in the M.I.T. Alumni Fund's Great Dome Associates has gone to over 1,350 donors to the 1981 Alumni Fund—a significant achievement in the first year of this effort to raise the level of giving to the fund, says Christian J. Matthew, '43, chairman of the Alumni Fund Board.

It was just a year ago that the board moved to establish the Great Dome Associates and give distinctive lapel pins (see photo) so that all their colleagues can recognize alumni who make individual Alumni Fund gifts of $250 or more, exclusive of corporate matching funds.

The following (excluding alumni who requested anonymity and those who are members of the M.I.T. Sustaining Fellows) are members of the GreatDomeAssociates for 1980-81.

(Annual membership in the M.I.T. Sustaining Fellows is extended to all who make annual gifts of $2,000 or more to M.I.T. for unrestricted or endowment purposes, and life membership in the Sustaining Fellows to all whose cumulative gifts exceed $25,000. A similar list of Sustaining Fellows will be published in a later issue of the *Review*.)

1905
William L. Spalding

1914
Charles H. Chatfield
Frederick P. Karns

1915
Nelson Stone

1916
Alexander Brest
Shatswell Ober
J. Douglas Robertson
Wilfred A. Wylde

1917
Chet Ames
Alfred J. Ferretti
John H. Holton
Alexander H. Kenigsberg
G. Hobart Stebbins

1918
John McClelland Abrams
William C. Foster

1920
Theodore W. Bossert
Harold Bugbee
Percy Bugbee
Warren L. Chaffin
John Nolen, Jr.

1921
Robert W. Barker
Harry Butters
Benjamin Fisher
Weston Hadden
Philip M. Johnson
Herbert A. Kaufmann
Leon A. Lloyd
John A. Scott
John W. Shepard

1922
Parke D. Appel
Bryant Essick
William W. K. Freeman
G. Dewey Godard
Francis M. Kurtz
William H. Lang
Milton M. Manshel
Edward J. O'Connor
Marjorie Pierce
Arturo Ponce Canton
Theodore Riegel
C. Willis Stose
Eugene V. B. Van Pelt, Jr.
Samuel I. Zack

1923
Douglas H. Alexander
William P. Allis
August A. Buhler
Charles T. Burke
Edward H. Clendenin
E. Bartlett Cocke
Benjamin Cooper
Harland C. Forbes
Harry Kalker
Scott V. E. Taylor
Frank J. Travers

1924
Harry G. Burks, Jr.
Allen W. Hawkins
Hayden B. Kline
Clarence W. Moore
Helen Gill Welling

1925
Willard C. Asbury
Harrison Browning
E. Willard Gardiner
James W. McGuire
Bruno E. Roetheli
Gilbert P. Tarleton
George L. Washington
Courtenay P. Worthington

1926
George E. Armington
Donald S. Cunningham
William W. Farr
William A. Forrester, Jr.
Clinton B. Galphin
John A. Gibson
Howard Humphrey
Argo E. Landau
George A. Makaroff
Benjamin Margolin
Charles Rich
Joel S. Tompkins
Arthur F. Underwood
John H. Wills

1927
Elwood A. Church
Edward H. Damon
Carlton G. Davies
E. Robert de Luccia
B. Allison Gillies
Gustavo Lobo, Jr.
Francis A. Mesker
Herbert Parkinson
John M. Pinkerton, Jr.
Harland P. Sisk
Frank C. Staples

1928
Lawrence F. Armstrong
Montague S. Burgess
Chester M. Day
Victor J. Decorte
James Donovan
Roland D. Earle
Newton S. Foster
Albert J. Gracia
Hector E. Hagedorn
Arthur C. Josephs
Morris H. Klegerman
David Olken
Francis C. Sweeney
Frank A. Taylor
Edwin C. Walton

1929
Lewis R. Aldrich, Jr.
Eric A. Bianchi
Karnig S. Dinjian
Arnold W. Ewan
Hyman J. Fine
Jarvis M. Hazard
Joaquin J. Llanso
Francis M. Mead
Herman P. Meissner
Austin S. Norcross
Daniel J. O'Connell
James C. Reddig
Thomas H. Speller
Edward D. Thomas
Everett P. Weatherly, Jr.

1930
Lawrence B. Anderson
Israel M. Cohen
Homer L. Davis, Jr.
Earl E. Ferguson
Howard S. Gardner
Joseph Harrington, Jr.
Maurice S. Herbert
Philetus H. Holt
Allan H. Meinecke
Hugh J. Mulvey
C. Haskell Small
Gregory Smith
Richard M. Wilson

1931
Lawrence B. Barnard
C. Randolph Binner
Charles Broder
Christopher John Chamales
Albert F. Coleman
John H. Dodge
Edwin J. Ducayet
Arthur G. Fuller
John R. Gardner
Harold D. Gurney
William J. Hallahan
Clement H. Hamblet
A. Hesselschwerdt, Jr.
Donald A. Holden
John G. B. Hutchins
Stuart R. Knapp
Addis E. Kocher
Chik H. Lam
Byron N. Martin
Carrington Mason
Joseph P. McBrien
Arnold L. Nylander
William A. Pitbladdo
Howard L. Richardson



Benjamin B. Shulkin
William A. Stellrecht
John R. Swanton, Jr.

1932
Wendell E. Bearce
Howard F. Carver
Melvin Castleman
James E. Harper
Byron E. James
Jack Kelman
John T. Kelton
George K. Kerisher
Guy C. Lentini
J. Alan MacDonnell
Arthur M. Marshall
Jacob Millman
Willis M. Moore, Jr.
Archie Riskin
Charles H. Taylor
Carroll L. Wilson

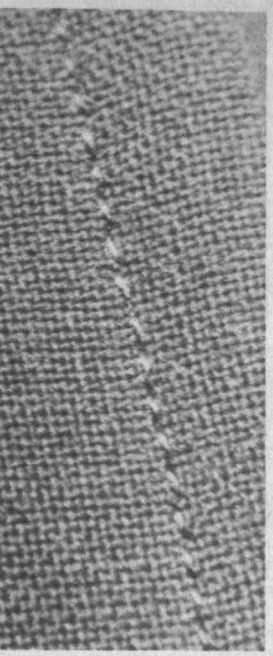
1933
George R. Churchill
George L. Cory
Guido M. Garbarino
George Henning
Wilber B. Huston
Charles Keller, Jr.
Paul J. Petitmermet
Otto A. Putnam
Henry A. Rahmel
Richard Robinson
William L. Sheppard
Laurance D. Sibley
Clarence R. Westaway

1934
Henry B. Backenstoss
William A. Baker
Robert C. Becker
Gordon K. Burns
Edgar B. Chiswell, Jr.
Elizabeth S. Close
Robert R. Cull
George Irvin Gahm
Stanley S. Knight
Wilfred D. J. MacDonnell
Douglas C. MacMillan
Arthur Miller
Frederick H. Pattee
Walter F. Read
Joseph L. Seligman, Jr.
Theodore Steinberg
Daniel D. Strohmeier
Carl H. Wilson
Walter L. Wise, Jr.

1935
George E. Agnew
John H. Anderson
Willard F. Bixby
Chester E. Bond
William W. Cross
Phoenix N. Dangel
Harold K. Farr
Ellis M. Flink
Robert F. Flood
Sidney Grazi
George N. Lykos
Bernard H. Nelson
Richard L. Shaw
Robert W. Spinney
Edward H. Taubman

1936
Kenneth J. Arnold
John Ayer, Jr.
Edward L. Brewster
Robert J. Caldwell
Norman A. Copeland
Bernard J. Cosman
Richard A. Denton
Dana Devereux
Caroline Bush Emeny
Stanley M. Freeman
Robert S. Gillette
Robert W. Hannam
Aurelius P. Hornor, Jr.
Henry Clyde Johnson
Earle V. Kinsman
Harold F. Miller
Henry C. Runkel
Dorian Shainin
Edson B. Snow
Fletcher P. Thornton, Jr.

1937
Wells Coleman
Raymond A. Dreselly
John H. Fellouris
J. Robert Ferguson, Jr.
Rutherford Harris
Robert Y. Jordan
Nancy O. Klock
Philip H. Peters
Harold E. Prouty
Norman B. Robbins
Jerome E. Salny
James H. Schipper
Joseph A. Smedile
Harry J. Sommer



Walter S. Wojtczak
Duane O. Wood

1938
Louis Bachmann
Howard Banzett
Armand L. Bruneau, Jr.
Dempster Christenson
Albert M. Clogston
Richard Henderson
Roy C. Hopgood
Robert L. Johnson
Solomon Kaufman
Walter F. Kaufman
John C. Kinnear, Jr.
Frederick J. Kolb, Jr.
James Maguire
Richard Muther
Paul O'Connell
Frederick E. Ray
Philip E. Sellers
Livingston S. S. Smith
Harold H. Strauss
Richard G. Vincens
David R. Wadleigh
Nicholas H. Wheless, Jr.
Albert O. Wilson, Jr.

1939
George W. Cannon, Jr.
H. King Cummings
William A. Davis
Charles F. Freyfogle
John I. Herlihy
August B. Hunicke, Jr.
George P. Morrison
William A. Murphy, Jr.
Irving Peskoe
W. Hewitt Phillips
Gordon A. Pope
John P. Renshaw
Samuel Sensiper
Seymour J. Sheinkopf
John A. West, Jr.

1940
Michael F. Biancardi
Paul V. Bollerman
Richard P. Dickson
N. Bruce Duffett
James E. Fifield
Harold Graham
Joseph H. Greenberg
Marshall D. McCuen
Joseph F. Owens, Jr.
Schrade F. Radtke
Richard O. Spalding
M. Spalding Toon
John A. Vanderpoel
L. D. Wheaton
George M. Wolfe
William S. Woodward
Boger Wright
Alfred C. Wu

1941
Herman A. Affel, Jr.
Roger G. Blum
Joseph S. Bowman
William T. Butt
Joseph E. Dietzgen
Martin L. Ernst
Robert M. Fano
Lewis D. Fykse
Sanford E. Glick
Rudolph W. Hensel
Sterling H. Ivison, Jr.
David Jacobson, Jr.
James W. Mar
Eugene A. March
Roger E. Robertson
Benjamin C. Scott, Jr.
Robert E. Smith
Peter H. Smolka
Frederick H. Thompson

1942
Lawrence E. Beckley
Curtis D. Buford
David Christison
Luther Davis, Jr.
Alfred T. Dengler
Edward Edmunds, Jr.
Philip E. Fox
Richard X. Gannon
Robert H. Given
Paul Hotte
Robert T. Howard, Jr.
Harvey Kram
Bernard Levere
Carl L. McGinnis
Richard E. Russell
Charles H. Smith, Jr.
William C. Tallman
George I. Toumanoff

1943
Virgilio Barco
George W. Bartlett
Lee A. Benson, Jr.
Howard M. Bollinger
Frank E. Briber, Jr.
Carleton F. Bryant, Jr.
Robert W. Caldwell, Jr.
Paul R. Coulson
Ira G. Cruckshank
Thomas K. Dyer
Howard S. Gleason
Sidney F. Greenwald
Ward J. Haas
Steven Heller
Rowland E. Hill, Sr.
William H. Horton
Wilfred Kaneb
Seymour C. Kapsten
Charles J. Lawson, Jr.
Hung Liang
Christian J. Matthew
James O. McDonough
Hugh Parker
Robert L. Rorschach
F. Curtis Smith
Kendall H. Spencer
D. Read Stevens, Jr.
Franklin H. Swenson
Herbert G. Twaddle
Hans G. Walz

1944
Martin Annis
A. Donald Arsem
Burton A. Bromfield
Herbert L. Carpenter, Jr.
Andrew F. Corry
Lee C. Eagleton
John B. Gardner
Mary E. Guinan
John H. Kellogg, Jr.
Samuel H. Lamport
Han Tang Liu
T. Gary Loomis
Richard A. Lopez
Peter M. Rinaldo
Eugene A. Schnell
Caleb S. Taft
Page S. Ufford, Jr.
Edward B. Walker, III
Richard E. Whiffen
James Woodburn
John Woolston

1945
William F. Blitzer
Christopher G. Boland, III
John J. Freiberger
James B. Hoaglund
Sheridan C. F. Ing
Andrew A. Marocchi
George E. McKewen, Jr.
Warren H. Miller
Nicholas V. S. Mumford, Jr.
David O. Richards
Malcolm L. Schoenberg
Clinton H. Springer
Thomas I. Stephenson, III
Daniel R. Vershbow

1946
Lyal D. Asay
Raymond E. Benenson
Ralph H. Berman
David G. Black, Jr.
Raymond D. Brown, Jr.
E. Fulton Brylawski
Ernest U. Buckman
Glen V. Dorflinger
Walter C. Gloekler, Jr.
Alan R. Gruber
Herbert J. Hansell
A. William McEwan
William H. Schield, Jr.
F. Thomas Westcott

1947
Kenneth L. Block
Claude W. Brenner
Harold Brown
John A. Contegni
Eleanor Edwardson Dorste
Thomas C. Dorste
Wilfred L. Freyberger
Richard T. Gregg
John G. Holmes
John Karmazin, Jr.
George J. Katz
Richard A. Knight
Byron O. Lutman
William J. McCurdy
Thomas McEvoy, Jr.
Leslie C. Merrill
Jack W. Rizika
Edwin A. Rosenberg
Martin D. Schwartz
Irving L. Schwarz
Wm. Reid Smith-Vaniz, Jr.
Howard A. Zwemer

1948
D. Dennis Allegretti
John C. Avallon
Jack A. Belz
Robert H. Bliss
Thomas J. Cahill
Albert F. Carr
Robert W. Deutsch
Robert P. Frenzel
Edward S. Frohling
Max E. Gellert
Curtis S. Green
Peter A. Guercio
Robert W. Hanpeter
John W. Hawkins
John C. Henderson
John E. Hill, Jr.
Irving Kagan
Norman H. Kreisman
George Macomber
Adolf F. Monosson
Robert R. Mott
John E. Nicholson
Thomas E. Pawel
Ralph I. Reis
Frederic M. Richards
Gilbert V. Rohlieder
Mitchell Silverstein
A. Graham Sterling, Jr.
Ellarson R. Stout
Donald F. Towse
Robert H. Welsh
Backman Wong

1949
Marvin A. Asnes
John W. Barriger IV
Orlien N. Becker
Paul S. Bercow
Robert C. Cowen
Ira Dyer
William S. Edgerly
Guilford W. Forbes
David K. Hardin
Charles K. Holmes, Jr.
Charles W. Holzwarth
John A. Knowlton, Jr.
Allan Kriegel
Thomas J. Lamphier
Ray E. Larson
Donald R. Merriman
Paul G. Miller
Ford F. Miskell
Thomas Moranian
Richard D. Morel
Oscar F. Noss, Jr.
Garland S. Sydnor, Jr.
Emilio J. Venegas

1950
Norton Belknap
William A. Black
Sterling G. Brisbin
Edward S. Cohen
William A. Farmer
Lawrence Gould
Charles F. Grice
Lawson P. Harris
Milton G. Hulme, Jr.
Robert D. Hutton
Carroll I. Johnson
W. Oliver Kincannon, Jr.
Raymond A. Kretschmer
John B. Lawson
Gerald A. Lessells
Alfred M. Petrofsky
Henry C. Sharp, Jr.
John M. Swick
Dan R. Test
Franz H. Tyaack

1951
W. Gerald Austen
Edward L. Bronstien, Jr.
William J. Cavanaugh
Jules S. Davis
William R. Donahue
Charles W. Ellis
Robert S. Gooch
John F. Hennessy, Jr.
Gerald S. Ikelheimer
J. Franklin Koehler
L. Gerald Marcus
James H. Michelman
John S. Prigge, Jr.
Bernard Rothzeid
Laurence L. Rubin
Samuel Rubinovitz
Arthur H. Schein
Charles H. Spaulding
Frank H. Thomas, III
D. R. von Recklinghausen
Frederick W. Weitz
Harry J. Zimmer

1952
Joseph F. Alibrandi
Richard C. Aquadro
Clyde N. Baker, Jr.
Jess L. Belser
Bock M. Chin
Clifford H. Heselton, Jr.
Harry S. Kradjian
Paul A. Lux
Joe F. Moore
Edward A. Ryan
F. Garrett Shanklin
Edmund H. Shea, Jr.
H. Stephen Spacil
Emil J. Volcheck, Jr.

1953
Alan D. Bercow
David M. Berg
Robert W. Chapman
Robert J. Gellert
Kent F. Hansen
David L. Klepper
Douglas L. Meyer
Robert R. Piper
Jean-Pierre A. Radley
Burton M. Rothleder
Bennett Sack
Tollyn J. Twitchell
Frederick Zwerling

1954
Gordon Aitken
Robert E. Anslow
Barbara A. Black
Wallace P. Boquist
Coleman Bresee
James W. Brown, Jr.
William J. Eccles
Inaki I. Elguezabal
William B. Gleckman
Thomas J. Henderson
Samuel J. Losh
Peter Paul Luce
George L. Perry
John E. Preschlack
David F. Springsteen
Robert W. Stewart, Jr.
David B. Whelpley

1955
Paul H. Attridge
Richard I. Bergman
Pierre D. Casimir Lambert
Zaven A. Dadekian
Alan S. Dana, Jr.
Gilbert Davidson
William T. Deibel
James H. Eacker
William Friedman, Jr.
Charles A. Gordon
Michael E. Halpern
Charles C. Ladd
Sheldon H. Moll
Theodore G. Papastavros
Farrel Peltz
Stuart S. Peltz
Edgar D. Pulsifer
Charles S. Robertson, Jr.
Randall S. Robinson
Walter Rubin
Bernard J. Sadoff
Allan C. Schell
W. Chandler Stevens, Jr.
David S. Wilbourn

1956
Robert D. Alter
Howard S. Bertan
George H. Brattin
Bruce B. Bredehoft
Stephen N. Cohen
Kreon L. Cyros
William R. Dickson
J. P. Diplarakos Weiller

Irwin Dorros
Richard H. Eastman
Frank Foster, III
Arthur Frank
Stuart Frank
Samuel S. Friedman
Larry R. Goldberg
William S. Grinker
Irwin C. Gross
Nathan L. Hazen
Richard A. Jacobs
Charles C. Joyce, Jr.
David L. Kaufman
John L. Kelly
Haim Kennet
Dimitri A. Manthos
Harold V. McKittrick, Jr.
Clifford K. Monzeglio
John A. Morefield, Jr.
Joseph P. Neville
William R. Oakes
Roberto Pardo Figueredo
Ira S. Polevoy
Jose M. Reyes
Harold H. Rothstein
James A. Royer
Nelo Sekler
Richard E. Skavdahl
John D. Stelling
Philip A. Trussell
Michael A. Turin
Stuart Z. Uram
Arthur Wickesser, Jr.
Francis H. Zenie

1957
George H. Borrmann, Jr.
John T. Christian
Gary J. Dischel
William H. Doughty
Ronald E. Enstrom
Robert Gal
Milton Ginsburg
Jordan L. Gruzen
Steven H. Hawkins
Edward L. Hoyt
Robert J. Jantzen
Eric G. Johnson, Jr.
Leonard P. Kedson
Alan M. May
Terrence K. McMahon
Frederick L. Morefield
E. Alan Phillips
Thomas S. Roberts
Peter A. Samton
Herbert F. Schwartz
Elliot K. Wolk

1958
Joseph J. Gal
William R. Hauke, Jr.
Robert E. Jordan, III
Calvin J. Morse
Robert Bruce Parente
Cornelius Peterson
Jaime R. Rosenthal
F. Helmut Weymar

1959
Hayward R. Alker, Jr.
Laurence H. Bishoff
Allan S. Bufferd
Terry L. Gildea
Martin F. King
Donald E. Murray
David F. Pawliger
Philip M. Richardson, Jr.
Earl J. Rogers
Paul G. Savage
Oliver E. Seikel
Lynn R. Sykes
Irvin B. Van Horn

1960
Thomas H. Farquhar
Standley H. Goodwin
Alan B. Shalleck
Arthur C. Silverman
Patrick S. Spangler

1961
William J. Hecht
William E. Jouris
Philip C. Kwok
Richard A. Mezger
Joseph R. Skenderian
William Strauss
Craig S. Tedmon, Jr.

1962
Thomas G. Burns
Vito A. Caravito
Edward A. Feustel
Aiyub A. Hoosenally
Gerald L. Katell
Robert F. Morse
Philip H. Nelson
Barrett B. Roach
Arthur J. Samberg
Vijaykumar J. Shah

1963
Edwin F. Brush, Jr.
James A. Champy
Tomas Goldberger E.
Stephen P. Kaufman
James W. Poitras
Ronald D. Rothchild
Charles C. Schumacher
Charles W. Selvidge
Daniel W. Shelley
Peter T. Van Aken

1964
Wayne F. B'Rells
Robert L. Blumberg
Leslie M. Boring, Jr.
Steven N. Iverson
Brian R. Kashiwagi
Joseph L. Kirk
Chun Chuan Kwong
Alton B. Otis, Jr.
Thomas C. Vicary
Otis C. Wright, Jr.

1965
Arthur A. Bushkin
W. David Carrier, III
Robert B. Grady
Dawn Friedell Jacobs
William N. Kavesh
John D.C. Roach
Gregory L. Schaffer
Carol E. Van Aken

1966
Arthur N. Boyars
William L. Bunce
Richard T. Cockerill
Ralph M. Davison
Victor K. Fung
Gerald F. Madea
Henry H. Perritt, Jr.
Ralph G. Schmitt
Frank E. Surma, Jr.

1967
Francisco J. Barberi
William M. Bloomquist
James W. Carter
John M. Davis
Alan B. Hayes
Edson C. Hendricks
Arthur C. Kwok
Henry J. Link
William E. Murray, Jr.
Russel G. Perkins, Jr.
Chet Sandberg
Andrew D. Skibo
Joel M. Steinberg
Arthur S. Warshaw

1968
Harvey Allen
Bruce J. Anderson
Paul A. Gluck
Peter Groot
Juan M. Meyer
Kenneth P. Morse
Jack A. Russell

1969
Dariush Ashrafi
David P. Kelleher
Michael W. Laird
Franklin P. Rogers
Christopher R. Ryan
Michael Sporer
Robert Swanson

1970
Gregory K. Arenson
Karen Arenson
James C. Bronfenbrenner
James L. Caldwell
Stephen F. Cooper
Irenee DuPont, III
Linda L. Furrow
Robert F. Gonsett
Richard C. Y. Hui
Albert C. Meyerer
David T. Patten
Patrick K. Snead

1971
Lester E. Byington

1972
John M. Bissell
Jack E. Cater
David A. Davis
G. Paul Hendrickson, Jr.
Hikaru P. Shimura
Robert E. Zahler

1973
John R. Bertschy
Mary J. Crooks
John W. Vander Meer, III

1974
Michiro Iwanaga
Mary A. (Bradford) McCarthy
Gary David Raymond

1975
Richard J. McCarthy

1976
Clifford F. Grimes

1977
Michael W. Sonnenfeldt

1979
Jose I. Garcia-Rojas

Advanced Studies in Engineering
Robert E. Pattison '72

Aeronautics and Astronautics
John A. Long '33
George S. Schairer '35
A. Tobey Yu '46

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Winston A. Close '35
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Elliot Saltzman '51

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Kenneth-Hung Fang '61
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James Lago '47
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Makoto Ohara '71
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Hugh W. Schwarz '42
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Martin A. Welt '57
Jack C. Williams '38

Chemistry
Clifton J. Blankley '67
Carl H. Brubaker, Jr. '52
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Lionel S. Galstaun '34
Emily L. Wick '51
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Kenneth C. K. Young '44

Civil Engineering
Arthur R. Anderson '35
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John F. O'Leary '66
Arthur C. Ruge '33
Elie A. Sehnaoui '61
Charles R. Walker '48
Roger H. Wingate '37

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Leslie Cookenboo '53
Vincent A. Fulmer '53
J. Wade Miller '48

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Anthony P. Di Vincenzo '47
Robert L. Frank '39
Irwin Mark Jacobs '57
Edward W. Kimbark '33
Kenneth E. McVicar '50
Charles W. Merriam, III '55
Morihiro Myodo '63
Campbell L. Searle '51

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Barbara A. Wolf '73

Management
George A. Bobelis '58
Carroll J. Brown '46
William L. Clifton, Jr. '70
Ruth L. Clinton '79
Maurice A. Garr, Jr. '49
Jonathan J. Golovin '75
Frederick L. Hall '67
Stephen A. Landon '68
John Norris Maguire '60
Robert Y. Mao '72
Wistar G. Metz '59
John D. Proctor '73
Arnold O. Putnam '47
Carlos F. Romero Moreno '66
Richard G. Schweikhardt '73
Lee L. Selwyn '69
William L. Sorensen '33
Paul A. Strassmann '55
Thomas R. Williams '54
Zenon S. Zannetos '55

Materials Science and Engineering
J. Howard Beck '35
Carl F. Floe '35
Joseph R. Lane '50
David G. Meade '58
C. Sheldon Roberts '49
Reinhardt Schuhmann, Jr. '38
Maurice E. Shank '49

Mathematics
Robert A. Clark '49
John H. Doles, III '69
Robert E. Sacks '75
Walter M. Swarthout '49

Mechanical Engineering
Robert H. Davis '50
Edward Hanley '48
Helge K. Heen '55
George E. Keeler '54
Ralph E. Schwind '51
Watson E. Slabaugh '30

Naval Construction and Engineering
Charles A. Curtze '38
Dean A. Horn '49

Nuclear Engineering
Harry J. Capossela '68
Dale E. Crane '67
William T. Miles '73
John M. Neill '61

Nutrition and Food Science
Darshan S. Bhatia '50
Jean-Louis Fribourg '72

Physics
H. Richard Johnson '52
David J. Rose '50
Donald T. Stevenson '50
Thomas W. Stinson, III '71
Parr A. Tate '53

Senior Executives Program
Andrew C. Knowles '76

Sloan Fellows Program
Robert S. Ames '54
Robert B. Anderson '66
Ray W. Ballmer '60
W. Gardner Barker '37
Eugene D. Becken '52
Wayne H. Burt '58
Roland B. Butterfield, Jr. '63
Robert H. Campbell '78
Richard A. DeCoste '77
Donald A. Dick '68
David K. Easlick '55
James C. Farley '50
Stuart M. Frey '61
H. Gordon Fromm '50
John H. Gerstenmaier '52
Leonard W. Golden '55
Frank H. Hall, Jr. '42
Ralph L. Hennebach '53
Donald A. Henriksen '68
Howard H. Kehrl '60
David A. Kinneberg '70
Allan H. La Plante '78
William C. Mercer '56
Geoffrey L. Moore '79
R. Dewey Rinehart '56
Barry Rosenberg '67
Robert E. Scifres '50
John H. Thacher, Jr. '42
Peter E. Viemeister '69
Charles E. Wampler '40

Undesignated
Philip A. Le Bar, Jr. '69
Elizabeth J. Yeates '74

Urban Studies and Planning
Allen G. Gerstenberger '74
Gordon Stephenson '38

Meetings and Conferences
A Schedule for 1981-82

The following major meetings and conferences are now scheduled to be held at M.I.T. during the year 1981-82. For further information, write to Joseph J. Martori, associate secretary of the Alumni Association, Room 10-115M.

October 9-11, 1981
Annual meeting of the Northeastern American Society for 18th-Century Studies

October 28, 1981
Seminar in automated welding research*

November 18-19, 1981
Seminar on trends and prospects in government regulation*

December 10, 1981 (Houston)
Seminar on offshore technology*

December 11, 1981 (Houston)
Seminar on vertical seismic profiling*

December 15, 1981
Seminar on organizational studies and human resource management*

January 13, 1982
Seminar on electrically conductive polymers*

January 23, 1982 (Seattle)
Conference on technology for the Pacific Northwest

January 28, 1982 (Los Angeles)
Seminar on advanced composites*

March 24-26, 1982
Second conference on computer graphics in CAD/CAM systems

June 10-11, 1982
Technology Day

June 14-17, 1982
Power electronics specialists conference

June 15-17, 1982
Conference on the macroengineering approach to managing large-scale technological development

June 17-20, 1982
Annual conference of the American Humanist Associaton

June 21-25, 1982
Seminar on finite-element methods in structural mechanics

August 2-5, 1982
Third international conference on the behavior of offshore structures

August 18-22, 1982
Research conference of the International Federation of Organic Agriculture Movements

October 2-3, 1982
Seminar on new developments in electrical engineering and computer science

*Attendance limited to participants in the M.I.T. Industrial Liasion and Associates Programs.

An Engineer's Anecdotes

Getting Sued and Other Tales of the Engineering Life, published this month by the M.I.T. Press ($15.00), began when a friend asked **Richard L. Meehan**, '61, what it is that engineers really do. Mr. Meehan found more in the question than meets the eye and thereupon resolved to attempt an answer "by telling some stories, hoping to convey something of the flavor of the technological life." The new book is the result.

Mr. Meehan's message is that engineering is just as much a human enterprise as medicine, law, or any other; "people and morals and delight and misery are all waiting to confront you whether you're a computer engineer or a public-interest or corporate lawyer or a village headman in Thailand." The anecdotal approach—in contrast to the systematic one usually chosen by engineers and scientists—is deliberate; recent experience convinces Mr. Meehan that his message is better conveyed by reconstructing his journals than by analyzing his life.

One turning point in Mr. Meehan's career occurred at the start of his sophomore year at M.I.T. As student number 570497, he'd not yet chosen a major. He concluded that he didn't know enough to join the lines for electrical engineering or physics; the line for mathematics was also long and slow-moving (and "a career in math is probably the same as that line," he thought to himself). But there was no line in front of civil engineering; indeed, the department head himself invited this mystified sophomore in for "a little talk." Subsequent chapters of *Getting Sued* reveal that it was a good choice; Mr. Meehan—he's now president of his own consulting firm, Earth Sciences Associates, Palo Alto, Calif.—has obviously enjoyed all sides of the life of a consulting engineer. There is the contrast between the theoretical analyst and the traditional action-oriented engineer, and there was the discovery that some of the philosophy from the humanities at M.I.T. was enlightening in a hearing room on the future of a small California nuclear reactor.

Mr. Meehan is a writer born to tell stories. He still remembers, for example, the "cameo profile of a girl, lean, blonde, face and neck tanned caramel, in fresh cotton . . . leaning against the ivy-fringed casement of an open window" at a party while he was being rushed (unsuccessfully) at the TKE house as a freshman in 1957. Alas, the girl never found her way to the SAE house, where Mr. Meehan was regarded as "a really neat guy."—*J.M.*

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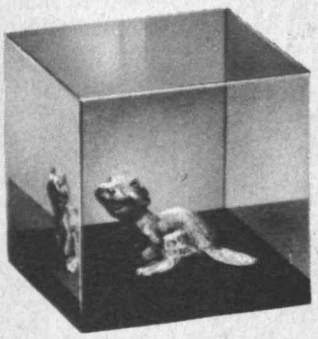
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Classes

05

Bill Spalding writes that he is in good health, though slowed down by gout in his hands and feet. He has recently moved in with his daughter and son-in-law (520 Kenosha Ave., Norfolk, VA 23509), who take good care of him.

I was so glad to hear from Bill. As yet, there is still no word from other surviving class members since I wrote them asking for news about themselves. I would like to keep the old '05 flag flying.

My daughter Frances recently bought me a clock at a store for the blind. It has no glass, and the hands are flexible and designed to be felt. I am in good shape physically with respect to my heart and lungs, but my feet and ankles are weak. I have had to use two canes and am looking into the use of niacin.—**Gilbert S. Tower**, Secretary, 35 N. Main St., Cohasset, MA 02025

08

From his son, Benjamin Wattles of Canton, Mass., we have the report that **Joseph Wattles** died April 27, 1981, at the age of 93. Joe, a lifetime Canton resident, owned and operated L. R. Wattles and Co., a chemical firm in Canton, for 20 years until he retired in 1962. He was also a Boston Edison employee for 30 years and was head of the steam heat department when he left the company. He was active in community and church affairs and was a past president of the Canton Rotary Club, Canton Historical Society, and the parish committee of the First Parish Unitarian Universalist Church. He also served on the board of directors of Norwood Hospital and Canton Institution for Savings. He leaves a son, a daughter, 14 grandchildren, and six great-grandchildren.

Joe was class secretary for 15 years and regularly attended the 1908 class reunions on Cape Cod. He did much to entertain us there. He will be missed—our deepest sympathy to his family.—**Harold S. Osborne**, Secretary, Penacook Rd., Contoocook, NH 03229

13

It is my sad duty to report to you that **Charlotte V. Sage** died on May 30, 1981, at her summer home in Whitingham, Vt., at the age of 92. Memorial services were held June 20 in Whitingham. Charlotte received her S.B. degree in architecture. She maintained a lifelong connection with the Institute and was a speaker at the opening of the exhibit M.I.T. Alumnae in Science and Technology in the Margaret Hutchinson Compton Gallery on May 7.

Her husband, the late **Nathaniel Sage**, served as placement officer at M.I.T. from 1937 to 1939, when he became acting director, and in 1940 director, of the Division of Industrial Cooperation. The Division was renamed the Office of Sponsored Research in 1954. Mr. Sage remained its director until his death in 1956.

Mrs. Sage is survived by a son, Nathaniel Sage, Jr., '41; four daughters, Mary Shakespeare, Mrs. John H. Case, Mrs. Carl Barus, and Mrs. George A. Saxon, Jr.; 15 grandchildren; and 17 great grandchildren.

Charlotte was a very loyal member of the Class of '13 and always kept her interest in class affairs as well as the entire Institute. She was loved by her large family and many friends. She will be greatly missed.

We have also been notified by the Alumni Association of the death of **F. Javier De Varona**. He died in Cuba two years ago. He is survived by a son, who also lives in Cuba.—**Rosalind R. Capen**, Assistant Secretary-Treasurer, 7 Brackett Point Rd., Biddeford, ME 04005

14

Word came in July of the death of **C. Shepard Lee** on December 6, 1980. He was with us in all four years, received his bachelor's degree in Course III, and had lived in Santa Barbara, Calif., for 60 years. I am trying to obtain information, beyond the very little in the class records, for an account of Shep's career in a later issue of the *Review*.—**Charles H. Chatfield**, Secretary, 177 Steele Rd., West Hartford, CT 06119

16

We had a marvelous time at our 65th Reunion, and the M.I.T. Endicott House was the perfect place for us to hold it. Joe Martori and Frances Bangs of the Alumni Office are to be commended and thanked for all their help with arrangements. Our thanks also go to Mimi Pearson, Ruth Morton and their staff at the Endicott House for all they did to make us feel comfortable. Throughout the reunion, 13 classmates and 24 guests shared part or all of the activities. They were Grace and **Dan Comiskey**, Irene, Betty, Bruce, Bob, and **George Crowell**, John, Frances, and **Paul Duff**, Sibyl and **Ralph Fletcher**, **Barney Gordon**, Rose and **Bob O'Brien**, Millie and **Charlie Reed**, Jane and **Chet Richardson**, Anne and **Izzy Richmond**, **Mickey Schur**, Frances and **Henry Shepard**, Stan, Bob, Frieda, and **Hy Ullian**, Lansing Warren, and Beverly, Edna, and **Nat Warshaw**. **Elbridge Devine** and his son and **Barney Gordon**'s son, Gene, joined us for the alumni luncheon and Anne and **Izzy Richmond**'s daughter, Jean, joined us for the Pops concert.

This was the first reunion that **Chet Richardson** had attended since the 15th Reunion, but he had a red jacket. When **Bill Leach** passed away several years ago, Helen Leach gave Bill's jacket to Chet. Jane Richardson accompanied her father, and she graciously assisted throughout the reunion wherever and whenever it was needed. Three of our group moved about in wheelchairs. Although it was obvious at times that the body was weak, the spirit was always overwhelmingly strong. At the class meeting, we elected **Ralph Fletcher** to continue as president for another ten years, and we elected **Bob O'Brien** to serve as assistant treasurer. **Francis Stern** continues as our treasurer, and **Jap Carr** continues as our class agent. Both Francis and Jap have served long and very capably in these responsibilities, and their classmates expressed their appreciation for the great job that they have been doing.

At our dinner on Wednesday, Chet Richardson led us in singing "The Stein Song." He still sings in his church choir. At our luncheon on Thursday, **Paul Duff** led us in a prayer of thanksgiving for the many blessings which have been bestowed on us, for the well-being of those classmates who were unable to be with us, and for all the departed classmates who are now sharing in the eternal happiness for which we all strive. Before leaving Endicott House, we made a reservation to celebrate our 70th there.

Since the reunion we have had telephone contacts with **Barney Gordon**, **Francis Stern**, and **George Ousler**, and all are doing reasonably well. . . . Paul Duff, who was hospitalized immediately prior to the reunion yet came to part of the reunion, is coming along. Francis writes, "We did enjoy seeing everyone." . . . Grace and **Dan Comiskey** write: "Everyone present seemed glad that they made the trip and expressed the hope of meeting again at future reunions, which are always so well planned."

Millie and **Charlie Reed** write: "We both thank you for the whole operation and realize there was a lot of work involved to make everything go so smoothly. Please give our best to Sibyl and the O'Briens. Your treatment of my friend, Lansing Warren, was most gracious. He calls his reunion visit the highlight of this year's return to the States." Lansing is a 1917 graduate from Stanford and has lived most of his last 50 years in Europe. He is a joy to know and has been invited to attend all our future reunions.

As has been our custom for many years, we sent copies of the reunion photo to most of the classmates with whom we have maintained contact. **Shatswell Ober** responds: "The class picture shows some rugged individuals with beautiful wives and splendid children in the background. In spite of the identification paper, I have difficulty recognizing many of the classmates. Thank you for the report of the meeting and address list." . . .**Charlie Crosier** notifies us of his wife's death and comments, "I am sorry to have missed the reunions but have traveled very little in recent years."

Unfortunately, we have several other deaths to report: **Rudy Gruber**, April 9, 1981; **Bill Willetts**, April 28, 1981; **Fred Upton**, May 12, 1981; and **Ed Graustein**, July 13, 1981. May they rest in peace. Keep eating, drinking, walking, breathing, everything in moderation, and yes, of course, keep writing.—**Ralph A. Fletcher**, Acting Secretary, West Chelmsford, MA 01863

17

A report from **Ossie Holt** from Woodland, Calif., advises that he and Florence celebrated their 62nd wedding anniversary on April 26 in a very modest fashion. He still drives a car, but Florence cannot enjoy more than 200-300 miles in any one day. On St. Valentine's Day they moved into their new retirement home, a brand new cottage in St. John's

Retirement Village. Ossie plays the piano for his own amusement and for the benefit of others who enjoy the old songs, old hymns, and lighter classical music. Their only granddaughter lives with her family in Woodland, which is the reason he and Florence moved there.

From **Stan Dunning** we have a report on Technology Day, which he notes was called Alumni Day 15 or 20 years ago when some 15 or 20 '17ers usually turned up. He says, "This year there were only four at our table—**Ray Stevens, Conchita Lobdell-Pearson,** and Jeannette and me. We were honored by having Conchita elected an honorary member of the Alumni Association. Charming as ever, she was tendered a special small dinner, which Ray and the Dunnings attended. The memorial service was standing room only and well done. The booklet for the service listed 20 names of active classmates who had passed on during the year. We now number 91."

Stan also noted the consideration we can look forward to when we attend our 65th Reunion on June 10-11, 1982. After the memorial service he and Jeannette had lunch in the fine new athletic building a good 600 yards away. As Jeannette is not very speedy afoot, they appealed to the campus police and were delivered in style—door to door in a cruiser. It appears that we can rely on the same attention and help next year.

Ray Brooks made his customary pilgrimage to Falmouth on the Cape where he, **Tubby Strout,** and **Ray Stevens** met for their traditional luncheon and talkfest. Ray Brooks is now the sole survivor of the World War I Aces.

Our strategy in persuading **Ken Lane** to assume responsibility for this month's news has paid off. He has, at long last, disclosed the following data regarding his own activities. In 1961, after 44 years of assiduous labor, he retired to a life of more strenuous labor with no monetary reward. For about 14 years, he and Betty spent about six months in their summer place in Madison, N.H., and the rest of the year in their house in Dade County, Fla. But, in 1975, after the New Hampshire place had been thoroughly burglarized for the second time, they sold it and became year-round residents of Florida. With their elder son Bob, a grandson, a granddaughter, a great-grandson (5), and a great-granddaughter all living in the same general area of Dade County, they have an adequate staff for social affairs. Their younger son Jack, '50, still lives and works in Jersey. As for activities, after giving up tennis because of faulty depth perception and golf because his game had degenerated to "cow pasture pool," for the past 11 years Ken has been active in the U.S. Coast Guard Auxiliary, mostly on SAR (search and rescue) patrols and regatta patrols but is devoting some time to CMEs (Courtesy Marine Examinations) and assisting in public education courses in boating skills and seamanship. The auxiliarists he works with are a friendly lot, and he finds the work interesting and rewarding but admits that his activity is not quite as energetic as it was a few years ago.—Acting Secretaries: **Kenneth M. Lane,** 8360 S.W. 148th Dr., Miami, FL 33158; **Raymond S. Stevens,** 100 Memorial Dr., Cambridge, MA 02139; and **Stanley C. Dunning,** 33 Christian Ave. (Box 218), Concord, NH 03301

18

Thanks to the class of 1917, there is a very fine pictorial history of M.I.T. displayed in the hallway leading from the rotunda to the Alumni Office. Among many other items of interest was the schedule of tuition in 1895—$100 for freshman, $125 for sophomores, and $150 for upperclassmen. So much for the good old days.

About a month ago, Selma and I together with Elizabeth Howe dropped in to see the **Julian Averys** and their beautiful garden. We all were particularly impressed with the enormous beech tree about 300-400 years old. Thanks to tender loving care by Jean and Julian, the tree has been pruned and developed to be one of unusual and spectacular beauty. Julian is still much involved in his new process for manufacturing magnesium, more of which we will hear about soon.

A note from "Biscuit" Chamberlain states that the M.I.T. Lincoln Laboratory requested the loan of a group of Sam's etchings for a show, a direct result of an exhibition of his prints at the Margaret Compton Gallery earlier this year. . . . **Mal Baber** reports his 65th Reunion in June at Yale. Faithful to 1918, he is looking forward in eager anticipation to ours in 1983. Jean and he are still adjusting to a move from a house to an apartment. They managed to get to Hilton Hotel, S.C., this spring for relaxation and rejuvenation. On their return to Philadelphia, they toured mile after mile of peach orchard country which they described as a magnificent spectacle. . . . **Charlie Tavener** reports he is keeping busy as vice chairman of the Boca Raton Community Redevelopment Agency and acting executive director of same, as well as being an active participant in the local Chamber of Commerce. Go to it, Charlie.

From time to time I have recorded answers from you to my question last December—can rugged individualism and the social welfare state have a successful marriage? I have saved **Herb Larner**'s comments—our thinker and philosopher—for the last of these ackowledgements. I quote him in part: "Human beings are fighting animals who must be controlled. Therefore, whatever the nature of the society, there must be law and order. Sociologists tell us that all races of people are equally intelligent. To quote the Bible, Matthew says, "Ye shall know people by their fruits." How can you compare the accomplishments of the underdeveloped countries with the Japanese, Israelis, and the Chinese in Formosa? To continue the social welfare state means the stronger, more intelligent, and more productive groups must provide for the less fortunate who are unable to adequately take care of themselves." He fears the rugged individualist who brings home the bacon may feel that he is not getting a fair break—hence the marriage may become weakened. Then what?

I regret to report the deaths of **Bertram Jones** and **Howard Allen.** No further details available presently.—**Max Seltzer,** Secretary, 1443 Beacon St., Brookline, MA 02146; **Leonard I. Levine,** Assistant Secretary, 519 Washington St., Brookline, MA 02146

19

George Michelson attended an Alumni Association gathering of M.I.T. senoir alumni at the Endicott House in Dedham and kindly wrote to say he was the only 1919 member there. Congratulations to George for his interest, though he felt a little lonesome. He continues his business and writes that he is now chairman of the trustees, his apartment having just gone condominium. Ninety-nine co-owners can and do give George some interesting experiences—"a great study in human nature."

I missed the Endicott House but with my wife, Florence, attended an M.I.T. club of Princeton forum on unmanned space exploration. The guest speaker was Professor Herbert Bridge of M.I.T.—timely meeting and discussion. At dinner, there we sat at a table with William C. Ridge, '24, and his wife Elinore.

I received a note from **Edward E. Scofield** which I quote in full. "I started working when ten years old raising chickens and am still keeping busy doing accounting work for two trusts. I can still walk several miles without a cane and when necessary drive my good old 1953 Chevy. My best wishes to you who are keeping M.I.T. on the map!" Let's hear more notes from others. We are all interested.—**Wilfred Langille,** Secretary, Box 144, Gladstone, NJ 07934

20

A goodly turnout showed up for Technology Day's luncheon, consisting of Betty and **Norrie Abbott,** Kay and **Frank Maconi, El Wason** and his charming daughter, **Al Burke, Ed Ryer, Phil Waite,** and the **Harold Bugbees.** The Class of 1920 was properly impressed by the loyalty and generosity of the donating classes as announced at the meeting.

Your secretary regrets to report the death of prominent and popular classmates. Dr. **Bob Aborn** of Millington, N.J., died last December. **Ernie Bangratz** of Lauderhill, Fla., died March 8. Ernie lived in Pittsburgh and retired to Florida. Dr. **Andrew McGowan** of Garden City, N.Y., died on April 4.

I am indebted to **Heima Haskell**'s son, H. Morgan Haskell, who succeeded his father as president of Brunswick Worsted Mills. He writes, "Dad was very proud of his Bowdoin/M.I.T. education. I remember the tale of his building a car that ran with a propellor, and he drove it from Cambridge to Wellesley for a date." Morgan sent me a clipping from the Hilton Head Island packet stating that Commander Haskell, USNR, was a mainstay of the yachting community on the island. His service to the Navy goes back to World War I. In World War II he re-enlisted and was placed in charge of production of engines and components for naval fighter aircraft. He served on the joint aircraft committee for U.S. and Britain and went to Germany to inspect captured missile bases. He was a member of the Navy League, the Wings Club, the Yacht Club of Hilton Head, and the Savannah Yacht Club.—**Harold Bugbee,** Secretary, 21 Everell Rd., Winchester, MA 01890

21

Well, our 60th Reunion has come and gone! It was a grand affair with 33 classmates and 24 wives attending. We arrived in Cambridge on the afternoon of June 3, some staying on the campus at MacGregor House and the others at the Hotel Sonesta down the river. Registration material was passed out at the Sonesta headquarters, together with a souvenir for the occasion: a collapsible umbrella for each person attending. The first assembly was at 5 p.m. for cocktails at the Sonesta. The room was soon buzzing with greetings, conversation, and amazement at the healthy appearance of our octogenarian classmates. **Whitney Wetherell,** however, won't reach 80 until November 8 of this year.

A bus took us over to the M.I.T. Historical Collections, stopping at the Walker Memorial steps for class pictures. We had a delicious dinner served with wine, and we were honored by the presence of Priscilla and Paul Gray. President Gray talked briefly after dinner, comparing M.I.T. in 1921 with M.I.T. in 1981. A certificate of honorary membership in the Class of 1921 was presented to Dr. Gray and a class gift of a flowering crab tree was presented to Mrs. Gray for the president's garden.

After breakfast the next morning, the class was bused through Boston along the waterfront to the Kennedy Library in South Boston. An interesting movie of John F. Kennedy's life was shown, and we had an opportunity to view many exhibits relating to the family and times during the last century. Leaving there, **Cac Clarke** passed out "smiley" button pins designed by his daughter Ellie and mailed to the Alumni Asssociation to give to Cac as a surprise. The features of the smiley face spelled out "M.I.T.-60th-1921-1981." They were delightful and adorned our red jackets for the remainder of the reunion. Lunch was at the Eastern Yacht Club in Marblehead—a delightful spot where we could look out at the multitude of boats in the harbor. We were back at MacGregor and the Sonesta for a short nap before a brief cocktail hour and dinner at the Hotel Sonesta. Buses took us over to Tech Night at the Pops where we heard another of those fine concerts given by members of the Boston Symphony Orchestra. So ended our second day.

Friday, June 5, the class joined the scheduled events of Technology Day: continental breakfast at the Student Center, morning and afternoon programs at Kresge Auditorium on the "Future of the Automobile," and luncheon at the Athletic Center. Three children of deceased classmates greeted one or more of us during the day: Nelson C. Lees, director of Resource Development at M.I.T., son of **Cornelia Nelson Lees;** Margaret Hill Hodges, daughter of **Sanford Hill,** attending her husband Jim Hodges' 30th Reunion; and Phyllis Rabinowitz, daughter of **Saul Silverstein,** also attending her husband Sam Rabinowitz's 30th Reunion.

The final event of the day was the class dinner and business meeting at the Brae Burn Country Club in Newton. Cocktails were followed by a delicious prime rib dinner—a gift to the class from **Ed MacDonald**. Flowers on the tables came from his garden. Guests that night were former M.I.T. president **Julius Stratton** and his wife Catherine, and *Technology Review* editor-in-chief John Mattill and his wife Anne. John gave a brief talk after dinner about the operations of the *Technology Review*, now recognized nationally as one of the top scientific journals and having a substantial circulation outside of the alumni.

During the brief business meeting, all of the class officers praised the planning and work of the reunion committee, consisting of **Donald Morse**, chairman, **Chesterton (Chick) Knight**, **Ed MacDonald**, **Frank Whelan**, and co-hostesses Marion Knight and Helen Zoller. President **Irving Jakobson** announced that the class giving to M.I.T. in the past five years exceeded $1 million and mentioned that part of this was the magnificent gift by Helen (Mrs. **Raymond**) **St. Laurent** of her Vinalhaven home that she and Ray occupied during many summers. The gift was given in Ray's memory. The secretary-treasurer reported that the class had about $4,400 in the bank and income was exceeding expenses.

The nominating committee consisting of **A. H. Rodriguez**, chairman, **Josiah D. Crosby**, and **Philip T. Coffin** presented the following slate of officers for the next five years: president—**Carole A. Clarke**; vice president—**Robert F. Miller**; secretary-treasurer—**Sumner Hayward**; assistant secretary—**Samuel E. Lunden**. The nominees were elected unanimously. And so concluded our reunion events.

Those attending our 60th Reunion were: **Wallace Adams**, Ruth and **Harrol Baker**, Chariot and **Robert R. Barker**, **Willard Brolin**, **Harry Butters**, Maxine and **Carole Clarke**, Edna and **Philip Coffin**, Claudia and **Josiah Crosby**, Bea and **Samuel Drew**, Mary and **Benjamin Fisher**, **Mahlon Hartley**, Alex and **Munroe Hawes**, Betty and **Sumner Hayward**, Ruth and **Irving Jakobson**, Vera and **Herman Kaier**, **Augustus Kinzel**, Marion and **Chick Knight**, Emma and **Al Lloyd**, Leila and **Sam Lunden**, Winn and **Ed MacDonald**, Mildred and **John Mahoney**, Helen and **Bob Miller**, **Don Morse**, Helga and **Jim Parsons**, Marion and **Philip Payson**, Graciela and **Heller Rodriguez**, **Bill Sherry**, Helen (Mrs. **Raymond**) **St. Laurent**, Hazel and **Whitney Wetherell**, **Harry Witherow**, **Frank Whelan**, Arthur and **Ed Wylde**, Helen and **Miles Zoller**.

Joining us for lunch on Technology Day were Virginia and Phil Johnson and our honorary classmate and former M.I.T. president, Jerome Wiesner.

A few bits of news were gleaned before, during and after the luncheon. The **Al Lloyds** had planned to visit their daughter's family in Switzerland this past spring, but shortly before departure Al came down with a painful bout of shingles so the trip had to be cancelled. He looks fully recovered now.

Several of our classmates are still working. **Bill Sherry** and **Sam Lunden** go to their offices about every day, and **Gus Kinzel** is still busy as a member of various boards of directors. Incidentally, Gus received his ninth honorary degree, a doctor of science from the New York Polytechnic Institute (formerly Brooklyn Poly) the day before he came to the reunion. Department of coincidences: **Bob Miller** tells me Bill Sherry phoned his wife Margaret in Tulsa the evening of Boston Pops and found she was watching the same Pops program on television.

Letters have come in since the reunion from **George Schnitzler**, **Wally Adams**, and **Phil Coffin** all saying what a fine reunion we had thanks to the reunion committee. Phil says he became a "cropper" just after he got home. "Four doctors' best guess is that some machinery in my digestive system got displaced after a near fatal bout with my surgeon 25 years ago. Diagnosis this time: 'pseudo obstruction of the cecum.' That's another useless gadget like the appendix."

Your secretary can report that Betty's "argument with the sidewalk and window ledge outside the Sonesta" has been settled successfully. The scar on her forehead is practically invisible, thanks to a beautiful job by the doctor at the M.I.T. Infirmary. Betty asks me to thank all those that have been so solicitous in inquiring about her.

It is my sad duty to report the deaths of three more classmates: **Robert R. Thurston** of Jensen Beach, Fla., on March 4, 1981; **Marshall H. Winchester** of Windsor, Conn., on April 30, 1981; and **Franklin T. Flaherty** of Lexington, Mass., on May 31, 1981. **Bob Thurston** was a veteran of World War I and worked in technical research for Texaco for 28 years prior to retirement. . . . **Marshall Winchester** worked for the engineering firm of C. T. Main in Boston for 15 years and for Travelers' Insurance Co. for 27 years, retiring in 1962. . . . **Frank Flaherty** was a patent attorney for duPont for over 30 years. He served as a second lieutenant in the U.S. Army in World War I.

The sympathy of the class is extended to their families.—**Sumner Hayward**, Secretary, 224 Richards Rd., Ridgewood, NJ 07450; **Josiah D. Crosby**, Assistant Secretary, 3310 Sheffield Circle, Sarasota, FL 33579; **Samuel E. Lunden**, Assistant Secretary, 1149 S. Broadway, Suite B-800, Los Angeles, CA 90015

22

Our 60th Reunion is coming up in June 1982. We had an excellent program and attendance at the June 1981 alumni celebration. We were provided with perfect summer weather for registration and the program at Kresge Auditorium. Your secretary was delighted to visit with James W. McLernon, president and chief executive officer, Volkswagon of America, a friend and citizen of Buffalo for many years.

The memorial services in the chapel were beautifully and impressively conducted, featuring James R. Killian, Jr., '26. We remembered our 28 class members no longer with us.

The luncheon included generous servings plus dessert, served most efficiently in the large first floor area of the athletic center. There were opportunities for table-hopping with classmates and other numbered groups. We enjoyed the company of **C. Hall Baker**, **Yardley Chittick**, **Oscar Horovitz**, **Zen Zuh Li**, **Fearing Pratt**, **Marjorie Pierce**, **Walter Saunders** of Cape Elizabeth, **Laurence M. Gentleman**, **Randy Myers** of Wilton, N.H., and a visit from **Dorothy Browning Johnson**. **Martha Munzer Corkland** wrote that she could not make it. The reunion class gifts were impressive, totaling several million dollars, some of which will be used for career development professors. Our gift has always been among the leaders.

Larry Gentleman writes describing his location in New London, N.H.—3,000 population, set in a fine recreation area with mountains for skiing and many lakes for boating, fishing, and swimming—all in the western part of New Hampshire on Lake Sunapee.

Your secretary is most grateful to have received notice as the 1981 recipient of the Harold E. Lobdell Award from the Alumni Association. We are honored as Lobby was our good friend and fellow conspirator for alumni planning for many years.

Our Class is well represented in Madrid, Spain, this summer. Madeline and **Parke Appel** visited their daughter and stayed in a village near Madrid for five weeks before returning to Venice. Parke has grown a mustache and goatee! He will return to work on our 60th Reunion soon. He reports a very pleasant evening with **Frank Kurtz** and has seen **Ray Ellis** occasionally.

As reviewed in our last notes, Dr. Michael D. Meyer has been named Class of 1922 Career Development Assistant Professor. He has been a member of the faculty since 1958 and holds a bachelor's degree from the University of Wisconsin, a master's from Northwestern, and a Ph.D. in 1978 from M.I.T., all in civil engineering. His testing and research were on transportation policy formulation and implementation of the role of engineer. Professor Meyer is presently a Danforth Fellow representing undergraduate education and has written numerous professional papers.

John Hennessy of Brookline has brought out his first volume of art photos entitled, *A Tender Eye*. He is planning his first gallery show this summer. Three of his six children have followed him into engineering and his daughter is an architect. . . . **William J. Schaefer** of Stamford, Conn., and Winter Park, Fla., has enjoyed Florida and is looking up old friends.

A memorial service was held for **Brian Mead** of Scarsdale in January. Brian was born in England and, until his retirement, was an engineer with the Exxon Corp. Our sympathy is extended to his wife, three sons, and eight grandchildren.

Thank you for your letters and cards, but we are expecting more. Our best to you all with hopes for more suggestions for the 60th Reunion.—**Whitworth Ferguson**, Secretary, 333 Ellicott St., Buffalo, NY 14203; **Oscar Horovitz**, Assistant Secretary, 3001 South Course Dr., Pompano Beach, FL 33060

23

Pete Pennypacker, Kay and **Julius Stratton**, and your secretary-treasurer were the only representatives of our class at the Technology Day Luncheon on June 5. John Tucker, director of Course VI-A, was a guest at our table.

Bill Gurney reports the arrival of a great-granddaughter last September. . . . **Miles Pennybacker** reports the arrival of his first great-grandchild and says that he is looking forward to our 60th Reunion. . . . **Norman Weiss** reports that he and Mary are doing well in their first year of retirement and that he has just finished the first volume of an autobiography and has started the second.

Captain **Walter Christmas** died on April 7, 1981. He graduated from the U. S. Naval Academy in 1920 and took a master's degree in naval architecture at the Institute in 1923. Through the 1930s he had an outstanding record of service in ship construction, repair, inspection, and maintenance of naval vessels in this country, the Philippine Islands, India, and Burma. For a time he served as instructor in electrical engineering at the naval academy. He served for a year on the aircraft carrier *Saratoga* as technical advisor. In 1941 he was assigned to the Bureau of Ships as head of the maintenance division, had temporary additional duty in Europe and Africa, and in 1945 was ordered to the West Coast as supervisor of shipbuilding at San Pedro, Calif. Later he was assistant industrial manager for the Eleventh Naval District in San Diego. From 1946-1950 he served in the Panama Canal Zone on the staff of the governor, in the Navy Department, Board of Inspection and Survey, and later as a member of the Munitions Board, Department of Defense. His service awards include: Letter of Commendation with Ribbon from the Secretary of the Navy for service in World War II, Victory Medal (World War I), American Defense Service Medal, American Campaign Medal, European-African-Middle Eastern Campaign Medal, and World War II Victory Medal. He retired in 1951 and became a consultant to the National Academy of Sciences.

Herman Bruson died May 31, 1981. He graduated in chemistry with our class, then went to Switzerland and obtained his doctor of science degree at Federal Polytechnik Institute. His first job was with Goodyear Tire and Rubber Co., where he isolated a white powder that could fasten heavy-duty truck tires to steel rims. In 1928 he joined Rohm and Haas Co. where he remained for 20 years and obtained over 300 patents, the most famous being for an oil additive that kept the lubricant fluid at extremely low temperatures. (*See May-June Notes.*) He was involved also in the creation of plexiglass, bactericides, pesticides, and flame retardant polyurethane foam. In 1952 he joined Olin Mathieson Chemical Corp., where he was vice president of chemical research until his retirement in 1966. After his retirement he became consultant for numerous chemical companies in this country and abroad. In 1971 he was awarded the Gold Medal of the American Chemical Society in recognition of his outstanding creativity and invention for human benefit. In April 1981 the New Haven Section of the American Chemical Society presented him the Maurice R. Chamberlain Award for improving the quality of life through chemistry, and in May 1981

he received the Eli Whitney Award of the Connecticut Patent Law Association for his contributions to science. The University of New Haven awarded him the honorary degree of doctor of science in 1980. His hobbies were golf, travel, and reading.

William Wise died July 1, 1981. He graduated in sanitary engineering with our class. Following graduation he was employed by Morris Knowles, Inc., in Pittsburgh, then by Buck, Seifert and Jost, New York. In 1928 he was employed by the Connecticut Water Resources Commission as associate engineer, became chief engineer in 1943 and director from 1952 until 1957, when he retired and became a consultant with Charles A. Maguire and Associates, Inc., Engineers and Architects. He was a fellow and life member, American Society of Civil Engineers; president, Connecticut Section, ASCE, and of the Connecticut Society of Civil Engineers; member, American Academy of Environmental Engineers; and a registered engineer in Connecticut. In 1957 he received the "Engineer of the Year" award from the Connecticut Society of Civil Engineers. In 1958 he was appointed by President Eisenhower as a member of the Water Pollution Control Advisory Board in the U.S. Public Health Service. He was a member of the Hartford Engineers Club; president, M.I.T. Club of Hartford; member, City Club of Hartford and Avon Country Club.—**Richard H. Frazier**, Secretary-Treasurer, 7 Summit Ave., Winchester, MA 01890

24

We have lost one of the most widely known and respected members of our class. **Frank Randolph Shaw**, our former class president, was the class agent for the Alumni Fund from 1946-1974, the period for which President Killian wrote, ". . . your example (the class) may well have far-reaching effects for the future." He was active in many organizations at the Institute and founded the Speakers Club. He earned his S.B. in Course XV and began his career with the Stanley Works, New Haven, Conn. He later joined Rust Craft Publishing Co. (now in Dedham, Mass.), advancing to vice president, from which he retired. In retirement he continued many civic activities, being a town meeting member, twice appointed to the advisory committee, treasurer of the Wellesley Council on Aging, and in 1979 was presented the Wellesley Community Center Award for distinguished service. In 1979, he was honored by the Insititute with the Harold Lobdell Award for outstanding service to alumni.

H. Royce Greatwood passed away May 27, 1981, in Marblehead Mass. He gained his S.B. in general engineering but was greatly interested in ships and served in the U.S. Navy during World War I. His ship was torpedoed, but after 18 hours in the icy Atlantic, he was rescued by a destroyer. After captaining the M.I.T. crew, he joined Union Oil in China. In World War II he again served in the Navy, then Union Oil in Japan before returning to the States. He became interested in the Allen Knight Maritime Museum of Monterey and contributed his entire comprehensive nautical collection. . . . Belatedly we learn of the death of **William McWane** in Birmingham, Ala., June 7, 1978. His widow kindly returned a card to the Alumni Office indicating that he had retired as president of McWane Cast Iron Pipe Co. . . . **Reuben Serge Piroomov** died February 7, 1981, in Westfield, N.J. He earned his S.B. in electrochemical engineering and his M.S. in chemical engineering. Little is known of his career, but he was with Standard Oil of New Jersey in 1949. His wife plans to contribute to the Alumni Fund in his memory. . . .**Richard N. Southgate** left us February 7, 1981 in Westfield, N.J., according to a note from his wife, Jessie Brainard. Dick gained his S.B. in Course XV and spent his entire career with Public Service Electric and Gas Co., retiring in 1967. Basically, he followed the electrical field. At one time, he was a member of the Board of Education of the Regional High School.

What a good time we had during our mini-reunion at the Woodstock Inn in Vermont (set in the foothills of the beautiful Green Mountains) June 5, 6, and 7. We enjoyed deluxe cuisine and hospitality. Participating were: Frances and **Walter Bagby**, Mary and **Roland Black**, Besse and **Phil Blanchard**, Marie and **Eric Brater**, Allora and **Clint Conway**, Anne and **Ernest Kallander**, Helen and **Perry Maynard**, Rene and **Ed Moll**, Helen and **Dick Shea**, Winnie and **Herb Stewart**, Terry and **Watty Waterman**, **Don Moore** and **Russ Ambach**.

Friday evening we gathered at the Country Club for a bountiful tenderloin dinner and then listened to Dr. George Schuitz, a dentist, propound on his hobby, antique autos. It was very interesting to many of us familiar with cars of 60 years ago. Saturday was open for individual pursuits due to the breakdown of the Stanley Steamer transportation. Also, one of the Belgian draft horses on the wagon ride had thrown a shoe.

The late afternoon was enlivened by cocktails and the raffling of two hand-painted watercolors contributed by Eric Brater. Eric, a prominent watercolor artist in the Cleveland, Ohio area, has been elected twice as president of the Lakewood Art League. Watty Waterman and your secretary were the lucky recipients. Then followed an unbelievably scrumptious buffet, topped with about 30 desserts. Sunday morning, we most leisurely munched a continental breakfast, bid good-byes, and were off to less verdant spots.

Technology Day was attended by **Bill Billard, Stu Morgan, Herb Stewart**, and **Don Moore**. It was more than a social get-together, for a portion was devoted to a memorial service for those departed who made the Institute what it is today. Our heartfelt sympathies are extended to the families of our members.—Co-secretaries: **Russell W. Ambach**, 216 St. Paul St., Brookline, MA 02146 and **Herbert R. Stewart**, 8 Pilgrim Rd., Waban, MA 02168

25

We have heard little of classmates in mainland China for many years, and news of them is much appreciated. Dick Knight, '47, was thoughtful enough to write me regarding a visit of Professor Shi Jiayang to M.I.T. on June 18, 1981. We knew the professor as **Chi Yang Shih** who entered the Institute in the junior year and obtained a bachelor's and a master's degree in mechanical engineering. While at M.I.T. Professor Jiayang met with many faculty and staff members. He is professor of hydraulic engineering at Qinglina University in Beijing, China. Also, he is the president of the Chinese Society of Hydroelectric Engineering. Professor Jiayang is interested in the relatively high use of hydroelectricity in the U.S. He noted that China is currently utilizing only five percent of available hydroelectric resources compared to 60 percent utilization in the U.S. China has major plans to increase its use of this energy source.

Roger Ward writes, "My activities have been greatly reduced by an operation on my spinal cord which has loused up my mechanism from the navel down; from there up I'm in pretty good shape. All I need is the transplant of the lower half of a runner in the Boston Marathon." . . . A further note from **Finley Laverty** refers to his mountain ranch located at 5,000 feet elevation in the Sierra Navadas.

The class was well represented at Technology Day last June. The following got together for the luncheon: **Will Gardiner, Jim Howard, Stanley Lane, Ed McLaughlin, Frank Mulcahy** and yours truly. President **Ed Kussmaul** made the Pops, but since Adele was much involved with her 50th Reunion at Wellesley, Ed had to miss the other activities of Technology Day.

Two deaths have been reported this month by the Alumni Association. **Joseph E. Russell** passed away in Houston, Tex., on February 18, 1980. Joe was well known to many of the class and will be remembered as a top quality tennis player representing M.I.T. in many collegiate tournaments. **Ello E. Richardson** died on April 24, 1981, at the North Adams, Mass., Regional Hospital following a heart attack at his home in Williamstown, Mass. Ello worked for what is now the Commonwealth Gas Co. with its main office in Westboro, Mass. When he retired in 1965 he was vice president of the company and was retained as a consultant since he was an authority in the field of the manufacture of domestic gas. Ello had built a retirement home in Williamstown and moved there in 1968. He leaves his wife, a daughter, a son, and four grandchildren.—**F. Leroy (Doc) Foster**, Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA

26

The 55th Reunion is now history. We intend to report in detail on its events and statistics shortly, for the moment being delayed until the accurate listing of attendees is available, after which we will send a copy to our classmates. Let it suffice to say at this stage that the weather was beautiful, the attendance large, the program pleasant and relaxing, and the opportunities for reminiscences and reunions available in a pleasant environment.

Ruth Southworth Smith was unable to attend and wrote expressing her regrets: "I just received the letter of the 55th Reunion. How thrilled Smitty would have been to attend it! He certainly was dedicated to M.I.T. I would love to be with you, but without Smitty my heart would break. I will be with you in spirit and I know that Smitty will also."

Some of us were reminded, on the occasion of "Pops" at the Reunion, that the author of the M.I.T. song is our own classmate **"Bud" Wilber**, who in response to a letter from Don Cunningham wrote: "Lillian and I, though we don't get any younger, are both well and keep reasonably active gardening and taking care of our place in general. I must admit that we don't travel very far afield. However, I am looking forward to accepting an invitation from the National Aeronautics and Space Administration next month to be present at a gathering to celebrate the 40th Annivesary of the Smith-Putman Wind Turbine on which I was chief engineer. As you may recall, it was built on Grandpa's Knob near Rutland, Vt., and for a time supplied electrical energy to the high lines of the Central Vermont Public Service Corp. Both Palmer Putman, '22, the designer, and Beauchamp Smith, the sponsor, are expected to be there. Mr. Smith was a member of the Corporation Visiting Committee for civil engineering at M.I.T. during part of the time I was head of the department. He was also a generous contributor to the Hydrodynamics Laboratory. It isn't often that the past and present come together with what promises to be such a pleasant occasion." We recall talking to Bud many years ago about that project which, as circumstances in the energy area have developed, was so prophetic of present day needs.

Duties at the reunion prevented me from enjoying (as much as I would have wished) opportunities to chat with old friends, but Evelyn and I had a brief period at the pool to talk to **Austin Kelly** and his wife. Those of us who attended the pre-Pops dinner at the M.I.T. Museum had the opportunity to see Austin's gift of paintings. His interest in collecting books and art objects was stimulated by his graduate educational experiences at Harvard and Oxford. We discovered later, by accident, his generosity in donating valuable collections not only to M.I.T. but also to the Peddie School from which he graduated in 1921.

Bill Hoar had just returned from Karachi, Pakistan, which made him close runner-up to **Shantanu Kirloskar** from India as the most distant attendant. . . . **Marvin Pickett**, Bill, and I lived together at Phoenixville, Pa., when first out of M.I.T. and have had only rare opportunities of meeting together again—a matter which we promptly rectified.

And now to the sad news of our departed friends. A letter form **Bill Bunnell**'s widow tells of his death on January 21 of pneumonia. They had been living since 1926 in the Reading, Pa., area, where he started as engineer for Consumers Gas Co., later to become UGI. Bill became vice president from 1956 to his retirement in 1966. Our sympathy to his widow, children, and grandchildren.

Delayed notice was received of the passing of two classmates. **Grant G. Speer** of 1722 S. Sherbourne Dr., Los Angeles, CA 90035, died April 4, 1981. . . . From his wife we received word of the passing of **Pete Ruggles** of 75 Prospect St., Amityville, NY 11701, on June 9, 1981. We missed them at the reunion which they had planned to attend.

Pete enjoyed yachting as one of the board of governors of the Unqua Corinthian Yacht Club and was a founder of the Narrasketuck Yacht Club. He was a member of the Propeller Club of the Port of New York, the Society of Naval Architects and Marine Engineers, the Amityville Historical Society, and president of the Amityville Businessmen's Club. The class shares with his widow, the former Cecil Hudson, her loss of a husband of 52 years.—**William Meehan**, Secretary, 191 Dorset Rd., Waban, MA 02168

27

Raymond F. Hibbert, our reunion chairman and wife Zella hosted a mini-reunion at their home in Madison, Conn., June 27. Eleanor and **Laurence W. Day** (hereby nominated tennis chairman) from Guilford, Lillian and **Laurence B. Grew** from Branford, Martha and **Lee McCanne** from Old Lyme, and Gretchen and **Robert A. Engel** from Southbridge attended. Louise and **Alan S. Beattie**, who live in nearby Clinton, were not able to join them. Ray writes: "Many questions were asked about our 55th coming up. The plans to return to Wianno (scene of our 50th) after the Cambridge festivities were received with enthusiasm. One of the features was a toast I offered to celebrate my second (in a lifetime) hole-in-one on June 17. The first one was back in 1968. (Ray should offer a cup with his name on it for the next hole-in-one in our class.)

"Our get-together was so successful that I am sure we will do it again. We spoke with Molly Lyles a few days ago, and she reports she is doing fine. We also saw Jean Arnold a few weeks ago enroute to her reunion. (We hope they both come to our 55th). Ray and Zella spent seven weeks in California from January to mid March with a month stay at Borrego Springs and visits with daughter in Brawley in the heart of the Imperial Valley; in July a week with son John in Killington, Vt."

By now you will have recieved the reunion questionnaire letter referred to in previous reports. Delay in mailing should be attributed to the Alumni Office who took an active role in helping reunion committees and recommended that September was a more appropriate time to initiate publicity. We hope you have sent in your replies about attending. You don't have to go to Wianno if you don't wish to, but many reunions go to a hotel on Cape Cod for a few days with classmates and wives. Transportation will be organized by the committee. If you haven't come to reunions before, make it next year!

Adelbert N. (Al) Billings, who made his career as tire development engineer for Kelly-Springfield Tire Co., Cumberland, Md., has moved again in his retirement to Richmond, Va., where their oldest daughter lives.

Captain **Milo R. Williams** died on November 11, 1980, in San Diego. He was professor emeritus of mechanical engineering at Tennessee Technological University. . . . **Francis B. Thorne** died on April 20, 1981, in Ormond Beach, Fla. He spent his entire career with Eastman Kodak and retired in 1964. (*See November 1979 Notes.*) **George W. Bergman** died on May 9, 1981, in Knoxville, Tenn. After many years with Joy Manufacturing, he retired to his adopted and beloved community of Knoxville. . . . **Francis A. (Frank) Mesker** died on June 9, 1981, in Florissant, Mo. He retired from the presidency of his family company, Mesker Brothers Iron Works of St. Louis, in 1960. In 1970 he had the great misfortune of losing his eyesight after many operations for cataracts and detached retinas. He enjoyed our reunions and was a strong supporter of his fraternity chapter of Sigma Nu. He leaves his lovely wife Pauline, three children, and eight grandchildren.

Our heartfelt sympathy is extended to the widows and families.—**Joseph C. Burley**, Secretary Protem, 5 Hutchinson St., Milton, MA 02187

28

Technology Day provides a wonderful opportunity for classmates to gather on campus each year in Cambridge. Class of '28 is usually well represented and this year was no exception. Those present were: Rose and **Maury Beren**, Frannie and **Jim Donovan**, **Hector Hagedorn** (from Spain), **Fred Lewis**, Jo (Mrs. **Edward M.) Shiepe**, Florence and **Walter Smith**, Anne and **Ford Tibbetts**, Lucile and **Sam Weibel**. We were pleased also that Helen Harris and Jan (Mrs. **John W. Chamberlain**) Sawyer could be with us for Tech Night at Pops. Although **Phil Taylor** did not attend, we did talk with his brother, Dwight, '26, who reported that Phil and Iris are in good health.

A note from **Aleck Tsongas** tells us that his daughter Katherine's recent marriage to Richard Silverblatt was the occasion for a great family reunion that included many notables like Senator Paul E. Tsongas from Massachusetts. . . . Olive and **Newt Foster** wrote that they spent three months of last winter at a trailer camp near Flagler Beach, Fla. Now they have expanded from a 22-foot home trailer to a 35-foot Park model and expect to spend more time in Florida next winter. . . . A letter from **Gerry MacGillivray** in Illinois says he expects to be visiting in New England for the fall foliage show. He included a nice portrait photograph of his son, Ken, and family. They are beautiful people and Gerry's pride in them is quite understandable. . . . **Eleanor Pepper** says that she is very proud to have been included in the exhibit of alumnae work (1873-1980) by women graduates of the Architectural School. . . . A brief note from **Hy Weinberg** says that he has been looking forward to our 55th Reunion ever since the 50th. His enthusiasm suggests that he must be in good health and spirit. . . . We had a nice telephone chat with **Chuck Carter** and he too appears to be in good condition.

From **Allan Tarr** we have a lively letter indicating that Allan must be one of the busiest members of the class. In his professional field of materials science he has had two patents issued in the past two years. These add to the many patents already to his credit. Allan's productive years have covered many areas of interest. They include industry (seven companies), government (three agencies) and teaching (five colleges). With all of this he has found time to write poetry and fiction, devise games, and produce inventions. He now regularly manages the Tarr Security Services which include all aspects of expert locksmithing. In recent months **Bill Hurst** has been one of our steadiest correspondents. His professional field is petroleum reservoir engineering and he is now expanding his office capability with added technical talent. Bill believes that one of our country's neglected resources is in the many oil wells and fields that were abandoned when output dropped during the days of cheap oil. In today's market many could be made profitable again.

It is with deep regret that we must report the deaths of two classmates. **James A. Cullen** died on July 2, 1981. Many of you will remember Jim for his accomplishments as an athlete in his student days. He was captain of the 1928 Wrestling Team. During most of his professional years he operated his own contracting and real estate businesses, was active in local politics and served in many distinguished positions of public service. Besides wife Helen, Jim leaves four sons, two daughters and 13 grandchildren. Daughter Franceline (Leary), '55, and grandson James Leary, '80, are both M.I.T. graduates.

Douglas A. Tooley, Course XVI, aeronautical engineering, died on June 11, 1981. His wife, Florence, was kind and thoughtful in sending us the information. Doug was in aeronautics during all of his professional life and served with several prominent companies including Republic Aviation and General Dynamics. The Tooleys' son, Richard, '54, received both S.B. and Ph.D. degrees (physics and geology) at the Institute. An expression of sympathy has been sent to the families of these classmates.—**Walter J. Smith**, Secretary, 37 Dix St., Winchester, MA 01890

29

For an off-year reunion our class was well represented on Technology Day 1981. There were seven '29ers present, as follows: **Bill Baumrucker**, **Arthur J. Bearce**, **Putnam Cilley**, **Frank Mead**, **Newell W. Mitchell**, Olive and **John Rich**, and your secretary.

Laurence L. Waite of Los Angeles, Calif., writes, "I don't know how you keep up sending so many birthday greetings to our classmates! The card you send me every year is always welcome and appreciated. I saw **Jim Reddig** the other day at the AIAA convention in Long Beach. Except for a few pounds he has added, he looks the same as when we were at M.I.T. I was in the South Pacific over the past holidays (Christmas and New Year), and while there, I picked up a virus and lost 14 pounds in ten days. I don't recommend this procedure to any Weight Watchers member. My best to all our classmates." . . . June and **Bill Young** of Old Saybrook, Conn., spent a very enjoyable week last March with Helen Hamilton (widow of **Hugh Hamilton**) in Boca Raton, Fla. June is holding her own and is scheduled to enter the hospital for chemotherapy.

Dr. **Sydney Darlington**, adjunct professor at the University of New Hampshire in Durham, N.H., was the recipient of a medal of honor from the IEEE. This award is the highest in electronics engineering, and he received it for contributions in the field of communication engineering. . . . **E. Gunnar Peterson** of Fort Lauderdale, Fla., writes, "I have reached the age of 78 years with reasonably good health and consider myself lucky enough to live nine months in Florida and three months in the summer in Woods Hole, Mass., if we are not traveling. Every two years or so we get a passion for a cruise. This summer we plan to take a cruise for three weeks leaving New York and going to Newfoundland, Iceland, Quebec, back to New York, and then the Cape. Thank you for the birthday card." Gunnar has two children and four grandchildren and lists "speculating on the destiny of Homo sapiens" as one of his hobbies. . . . Martha and **Ira H. Abbott**, who were present at our 50th Reunion, celebrated their 50th wedding anniversary. They have three children and six grandchildren. Ira lists woodworking, salmon fishing, and golf among his hobbies.

Edwin H. Perkins of Boxford, Mass., writes, "I have been retired now for ten years and am doing all the things that I could not do before for lack of time and money. For the past seven years I have been chaplain or marshall of our Masonic Lodge, treasurer of our Eastern Star chapter, and have gone through the bridges of our Merrimac River Squadron, D18 of the United States Power Squadron." Edwin has one child and two grandchildren, and he lists boating, teaching, and photography as his hobbies. . . . **Jonathan F. McCray** of Heber Springs, Ark., who attended our recent 50th Reunion with his wife Isabel, writes, "Many thanks for the birthday greetings. I have been involved with a committee which is set up to give help to retired people with income tax problems. We have been so succussful that we have decided to set aside one day a week in a designated place where people with tax problems can come for consultation." . . . Your secretary and his wife Helen enjoyed a visit with **Neal Wells** and his wife Helen at their home in Hampton, N.H. The Wells, who have been living in Pinellas Park, Fla., for the past ten years or so, have their roots in Massachusetts and Pennsylvania. As such, most every summer they visit their friends and relatives in both states. We have enjoyed a number of such visits in the past.

Henry A. Ambrose of St. Petersburg, Fla., has been retired from Gulf Oil Co. since 1967 and enjoys the gentle climate of southern Florida. He was a director of the new products division at Gulf Oil Corp. . . . **Edward B. Papenfus** of Vancouver, B.C., writes, "I have just returned from a three-month visit to South Africa. I was very much impressed with the tremendous progress the country has made in the construction of freeways in and around most major cities and the greatly increased prosperity and living standards for the whites as well as the blacks." . . . **Len Paskin** of Wyncote, Pa., has sent me a sad note that his wife Martha passed away suddenly last November after a massive heart attack. Len and Martha have been some of our most loyal and active members of the class and have generously supported the class and M.I.T. affairs. Her passing will leave a void in the hearts of many of their friends. There is a happier ending

though, as Len has been remarried since, to a friend of the family, known to both for many years. We all wish them a happy life together.

I regret to announce the death of one of our classmates, **Everett F. Kelley** of West Dennis, Mass., on June 21, 1981. A note from his widow says, "Everett passed away last June after his second heart attack. He was a wonderful man, devoted husband, and good father."—**Karnig S. Dinjian**, Secretary, P.O. Box 83, Arlington, MA 02174

30

As I previously reported in the Notes, **Win Hartford** has been quite active in the field of environmental science in recent years. He says that he is now "fully emeritus" from Belmont Abbey College where he taught for a number of years. He is now devoting all of his time to writing, speaking, and serving on committees dealing with the environment. His main thesis is that the scientific-thermodynamic approach to environmental problems is far more effective than the "polarization" or "legal adversary" approach. Last year he was invited by the Royal Society of Chemistry to speak on chromium chemicals at the University of Salford. He also gave papers at the A.C.S. meeting last December on acid rain and dosage response curves and control of carcinogens. . . . **Tom Wigglesworth** is still active as board chairman of T. R. Wigglesworth Machinery Co. of Bedford, Ohio, and has retained his enthusiasm for tennis, which he plays regularly. The Wigglesworths live in Shaker Heights. . . . **Sol Uman** is semi-retired but still does some consulting work in the construction industry. The Umans are now living in Pompano Beach, Fla., where they have purchased a "condo," which is the reason why they were unable to attend the 50th Reunion. At the time of the reunion they had just moved into their new home and couldn't get away. Because of his engineering and construction experience, Sol has become a member of the condo board of directors. He is also a past president of the Nassau County Chapter of the New York State Society of Professional Engineers. Sol and Beatrice celebrated their 21st wedding anniversary this year; the marriage is a second one for both of them. As a result of the merger they have three children and eight grandchildren. . . . **Joe Kania** is still making annual trips abroad as a member of the Vancouver, B.C., Board of Trade Mission. On last year's trip he went to Mexico, Panama, Guatemala, Costa Rica, Curacao, and Venezuela. This year's trip included New Zealand, Fiji, and Australia. Joe sent me a sketch of his self-designed Vancouver home. It is an isosceles triangular house built on a triangular lot. . . . **Bill Waite** recently attended his 55th Reunion at the Wakefield (Mass.) High School and there learned from Carolyn Mann MacVicar that her brother and our classmate **Hayward Mann** died about four years ago. From Bill's comments and the *Alumni Register*, it appears that he spent most of his career on the West Coast working in the semiconductor division of Hughes Aircraft Co. in Culver City, Calif. As of 1955 he was sales manager of the semiconductor division.—**Gordon K. Lister**, Secretary, 294 B Heritage Village, Southbury, CT 06488

31

Charles Broder writes, "After retiring in 1973 as chief mechanical engineer for the Port Authority of New York and New Jersey, my wife Bea and I still live in New York, enjoying the art and music that is available here. We travel through the U.S. and abroad, spending what time we can with our two sons and three grandchildren." . . . A brief note from **Philip Donely** says, "Every time I shoot for a reunion, a trip to England comes up." By now, of course, our very successful 50th Reunion is a thing of the past. Weatherwise, even for the clambake, it was good. Meeting so many old friends from our college days whom I hadn't seen for years was indeen a pleasure. . . . **Charlie Wood** found he could attend the reunion at the last minute. After touring around Martha's Vineyard, he liked it so much that he hopes to spend more time there. Charlie has turned out to be quite a photographer, and we are looking forward to some of the pictures he promised. Between Charlie and **John Olsen**, our 50th was probably the most photographed reunion ever. John also is sending us photos.

A few days ago, **Fred Elser** phoned me from Honolulu to say that all is well there. . . . I enjoyed seeing and chatting with **Leo Green** at the Reunion. Leo has made quite a name for himself as an orthopedic surgeon and now hopes to arrange a little more spare time for himself, during which he hopes to get back on the air with ham radio again. . . . I was glad to see and talk with **John Hollywood** at the reunion. John, temporarily off the air, expects to be back on his ham radio again in the relatively near future. . . . **Dick Kropf** was another classmate at the reunion whom I hadn't seen for many years, although we have exchanged Christmas cards throughout the years. He looked fine and hasn't changed much since our M.I.T. days.

This month, death notices of the following classmates were received. Our sincere condolences to their families. **Carl Connable**, whom I knew well during our M.I.T. years, died May 1, 1981. **Donald E. Houghton** passed away on May 4, 1981, after a 16-year bout with bone cancer. **Harold S. Rice**, who worked on the first atomic bomb, died on May 25, 1981. **Charles W. Steinbach** departed this world last November 1980 due to an obscure paralysis. **Franklin W. Zwicker** died as a result of an operation to remove a brain tumor at Maine Medical in Portland, Maine, on April 3, 1981. The saddest part of your class secretary's responsibilities is reporting the deaths of my classmates.—**Edwin S. Worden**, Secretary, P.O. Box 1241, Mount Dora, FL 32757; **John R. Swanton**, Assistant Secretary, 27 George St., Newton, MA 02158; **Ben W. Steverman**, Assistant Secretary, 3 Pawtucket Rd., Plymouth, MA 02360

32

On June 18, **Ed Nealand**, as chairman, conducted the first meeting of our 50th Reunion Committee. **Nick Flatley**, our class president, flew in from Washington. Others present were **George Kerisher, Melvin Castleman, John Finnerty, Donald Whiston, Donald Brookfield, William Pearce, John Brown, Arthur Marshall**, and Frances Bangs of the Alumni Association.

Our primary objective will be to have as high attendance as possible at a low cost. It will be an excellent opportunity to meet old friends and to make new friends. We are bound by our association to M.I.T., and no one need think he is a stranger. Details of plans will follow.

Ray W. Hawksley is still very active in his own company and at present has no thoughts of retiring. He has two sons, seven grandchildren, and one great-grandchild. . . . **Lee Tyburski** writes that he is a grandparent again. His wife Norma has gone to San Diego to greet the newcomer and he was left in the Poconos to fight the weeds. In the fall they plan an auto trip to San Diego. . . . Through the grapevine, I learned that **Ed Blaisdell** spent six weeks in England and Scotland. How about writing us some details and impressions of your trip, Ed? . . . **Ed Eddy** retired from Grumman about eight years ago and is now living in Winsted, Conn. He has a grandson, age 14, who is interested in going to M.I.T. Ed will do his best to guide him there.

Arthur M. Marshall makes the news again. During the July 4 concert of the Springfield Symphony Orchestra, he conducted the Rodgers and Hammerstein "Oklahoma" medley. Also, the State of Israel Bond Committee honored him for his community activities. . . . **Albert Dietz** writes that ever since graduation he, **Henry Chapin, Bob McCoy**, and **Howard Quigley** have kept in close touch with each other. Even after Bob died, his widow Helen (now remarried) has kept up the relationship. She invited all of them to her home in Glenside, Penn. It was like a mini-reunion, and a marvelous time was had by all.

I have recieved the obituary of **John Yeager** of Wayland, Mass., who died unexpectedly on April 3, 1981. John was a well-known businessman and sportsman. He was a partner of an insurance company until he retired a few years ago. He was active in civic affairs and in banking circles, besides being an avid tennis player, sailor, and amateur radio operator. He leaves his wife Rose and two daughters.

We have received the sad news from the Alumni Office that the following classmates have died: **Carrol Milton Daniell** of Dallas, Tex., on February 11, 1981, and **Farrow L. Tittle** of Montgomery, Ala., on January 10, 1981. When we receive obituary information, we will pass it on.—**Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

33

Considering the reports of the reunion chairmen on their fund raising results, this Technology Day was one of the best ever. One cannot help feeling proud of the generosity of all the alumni who participated in all the reunion drives. I was also gratified to note how many of our own fellows attended, to wit: **George Huff**, Mrs. **Ferdinand Johnson** (Ferdy was in the hospital nursing an ulcer), Greta and **Tom Galvin**, Mildred and **Julian Klein, Ed Simpson**, Anne and **Fred Murphy**. This is a far cry from the days when **Tom Galvin** and I were, each year, the only '33ers attending.

Wonders will never cease, and surprises are always welcome. We hear from **John R. Wiley**, the one and only, that he retired early as director of aviation, Port of New York, got himself married, and joined the teaching staff at M.I.T. He has been teaching ever since, in the aeronautics and astronautics department. John has also joined the ever popular group of consultants. We have every right to be proud of our famous classmate, and John, we salute you. . . . After too long we have a fine postcard from **Bob Dillon**, of the Texas Dillons. He and Alice had just returned from a 12-day trip in the Baltic Sea, making the usual stops en route. . . . **George Stoll** is rapidly becoming a regular correspondent, and he does well. He just returned from a salmon fishing trip to one of the better lakes—Moosehead. It seems that he and **Jim Turner** have been camping and fishing in and around this great country since 1925. I, too, have fished this great state, mostly all over and down the Allegash twice, as they have.

Jack Frost Andrews is the first to heed my plea to write a few times each year instead of sending the usual family letter. We have precious little space each issue, so it works better to include a few sentences about each classmate on a regular basis than to try to squeeze in long letters once a year. . . . The Andrews spent Christmas in Denver where Jermain has relatives and children. She also went again to Denver to officiate as grandmother. In March they both visited Farmington, Conn., where Jack's daughter lives. They also made the World's Figure Skating Championship at Hartford. Jack is set to retire in October, but will remain in New Jersey. As an aside, Jack announces that **Melville Ehrlich** has been elected president of the M.I.T. Club of Central New Jersey. How about a word, Mel? . . . Jack also sends a news clip on **John C. King**, who settled in Cleveland soon after he got out of school. John has become very active in the ASCE. He has been chairman of the Industry Survey Committee for eight years. He is a past president of the Cleveland section and has now become a life member of ASCE. Somewhere along the line he became a member of the Bureau of Reclamation and obtained his M.S. at the University of Colorado. He taught at Robert College, Istanbul for three years. John is now a consultant in concrete aggregate and concrete repair. Your class salutes you, John. How about a note from you?

We have a new correspondent, **Phil Cook** of Wilmington, Del. He begins with a little reminiscing, then describes a two-month trip to Great Britain. He and his wife Loraine were joined by Denise and Ed Blaisdell, '32, and they all spent a week together in Scotland and another week in England on the English canals in a rented "narrow boat." Phil and Loraine are now back in Wilmington, gardening—first tomato, July 2. Thanks a million, Phil. . . . **Bill Harper** writes at some length. He tells us that he

has been adivsed by Dr. Ernest G. Neapolitano, president of the New York Chiropractic College, that he has established the William D. Harper Scholarship Fund; this in addition to the Distinguished Service Citation in 1978, upon Bill's retirement as president of the Texas Chiropractic College. Bill has been asked to write his autobiography for use in the ninth edition of *Men of Achievement* of Cambridge, England.

We have three Fund capsules. **George Huff** writes that he is retired but still active as a consultant at Perkin-Elmer Corp., in the facility and real estate areas. He has one son, a civil engineer working with C. E. Maguire Highway Engineering. Another son is a research mathematician with the Mitre Corp. . . . **Bob Crane** contends that he and wife Marjory are still very much alive; they spend winters in Florida and summers on Cape Code. He also does a little consulting. . . . **Newt Buerger** says that he has moved from Texas to a condominium at Del Mesa Carmel, Calif., back in God's country. . . . For the first time in many years, there are no deceased to report this time. We wish we never had any. That's it for this time around.—**Warren J. Henderson**, Secretary, Fort Rock Farm, Drawer H, Exeter, NH 03833

34

A clipping from the *St. Petersburg Times* of April 6 was devoted to that city's annual Festival of States Pageant. What makes it of interest to us was the lead item about **Bill Mills, Sr.** who was named the 27th "Mr. Sun," an event that comes complete with robe and crown—the leading citizen in the Sunshine City. Bill, along with his son Bill Jr., is active in Mills and Jones, a major building concern in that area.

I'm sorry to have to report the deaths of two more of our classmates. The first is that of **Theodore Graves** of Bozman, Md. There is no information beyond the fact that it happened in October 1980. The second will be a particular loss to the Canadian engineering fraternity and especially to women in the profession. Mrs. **Elizabeth Macgill**, of Toronto, died in Mt. Auburn Hospital, Cambridge on November 4, 1980 after a month's illness. Her husband, Mr. E. J. Soulsby, notes that they had been visiting from Toronto when she became ill. If you follow this column, you will recall that a number of times in the past I have reported on honors awarded to Mrs. Macgill, honors that came to her from both professional and governmental groups. I would express the sympathy of all our class to the families involved.

An item from the *Brunswick (Maine) Times-Record* describes **John Newell**'s efforts to have one of Florida Power and Light's nuclear plants shut down because of safety and health risks. In 1980 he had also campaigned against the Maine Yankee plant. The article mentions that because he felt that he had been treated virtually as a "non-person" at the FPL's annual meeting he disposed of his holdings in the company.

A rather short, poignant Alumni Fund note from **Herb Andrews** states, "Nothing new except that my wife is seriously ill with cancer." All of us, I am sure, hope that the problem can be kept under control.

A note from **Harold Adams** says, "Retired as associate professor of environmental sciences at the Indiana University School of Medicine, Indianapolis in 1975. Now doing some consulting work and am editor of two publications for scientific and educational societies here in Indianapolis. All on a part time basis."

Rodolfo Gonzalez Garza writes, "For 20 years, head of the export department for a group of glass companies. Organized an exporter's association in Monterrey, Mexico. Remain as its honorary life president. Hobbies: travel, antiques collection, Chinese ceramics, and Oriental ivory pieces. Now retired and in active personal business."

Peter Kalustian is still hard at it. He says, "I am continuing to be very active in my international food fats and oils consulting business. Last fall I surveyed the industry in Taiwan for their government, visited the Philippines, and then ended up with eight weeks in Malaysia on a major plant start up, which I had engineered for several years. (Notice how smart these consultants are—they never do busness with somebody in Hoboken or South Bend—it's always halfway around the world! We dopes have to spend our own money when we want to travel!) Healthwise I have been doing well although last summer I did have surgery to correct a detached retina in my right eye. Skiing is still my winter recreation, and I have had over 40 days this season, including a vigorous week in Innsbruck. I keep close to my children and their families and really enjoy my two energetic grandchildren who live next door. My daughter really takes good care of me."

There has been a slight hiatus since writing the above because I was waiting to see **Jean Raymond**. I had a call from him that he and his wife were down from Montreal visiting their daughter who had rented a place here on the Cape. Jean had been getting to see some others of our class who are down here and we were finally able to get together for a talk. He is fine, still as full of life as ever. The day we met he had started at 7 a.m. playing tennis and when he left our house he was heading for another match. I hadn't realized how deeply involved with music he has been—he had brought his cello with him and Ralph Brown's wife, Ann, was able to arrange with two others to put together a string quartet for some chamber music. Jean is still active with his company that carries on the process he developed for depositing a mirror surface on thin, flexible materials. He told me of some of the work he has been doing with General Electric at King of Prussia,, Pa. In part it is consulting and in part supplying some of his materials—one of the projects was a parabolic dish to concentrate solar energy for the production of electricity.

This has developed into a frustrating spring and summer for the Franklins. We had hoped to pick up our aborted 1980 trip to England this past May. For various reasons this proved not feasible and I had just finished reworking the itinerary for a trip in September when, on May 25, I landed in the hospital again with another flare up from my heart. It was not too severe but my doctor and I agreed that a check on corrective action was due. So on August 2 I'll go up to Boston for tests that I hope will show coronary bypass surgery is indicated. It turns out that this is one of the most frequently and successfully performed operations in the country today. So with luck, I'm setting my sights on a trip in the spring of 1982. In the meantime, **George Bull** will hold the fort for the November/December notes.—**Robert M. Franklin**, Secretary, 620 Satucket Rd. (P.O. Box 1147), Brewster, MA 02631; **George G. Bull**, Assistant Secretary, 4601 N. Park Ave., Apt. 711, Chevy Chase, MD 20015

35

The following '35ers were present for one or more activities over Technology Day, June 5: **Randy Antonsen, Leo Beckwith, Chet Bond, Richard Cook**, Janice and **Leo Dee**, Jane and **Pete Grant**, Rhoda and **Bernie Nelson, Ed Taubman, Dave Terwilliger, Gerry Golden**, and Doreen and **Allan Mowatt**. We occupied two tables at the Alumni Luncheon in the new Athletic Center. A month later at the Faculty Club the following members of the 50th Reunion Gift Committee met with Chairman **John Taplin** and staff people from the Alumni Association: **Bissell Alderman, Randy Antonsen, Leo Beckwith, Ben Blocker, Nix Dangel, Allan Mowatt, Bernie Nelson**, and **Frank Sellew**.

A few weeks ago the *Boston Globe* had quite a long special article about **John Taplin**'s new interests entitled, "Putting Some Fun Back in Funding Inventors." John and Paul Montle, a 33-year-old economics graduate from Tufts, have formed the Taplin and Montle Development Fund with offices in the John Hancock Tower. The $40 million they have raised is to be used to help struggling inventors and companies who need money for research and development projects.

The 21st Annual Class Golf Tourney is under way with 28 participants. All the losers in the first round play in consolation flights, and the winners meet up with the winners of the main flights in early fall. We have had a number of head-to-head matches in eastern Massachusetts and Westchester County, N.Y., and most of them have been very close. **Bill Parker**, the 1979 champion, came to Acton with Marjorie to stay with their daughter and family. While he was here, we set up a match at Brae Burn with **Art Marquardt** and **Leo Beckwith**, who were playing their second round match which Art won on the 18th one up. I helped keep score and was so relaxed while not playing in a crucial match that I broke 100. **Chet Bond** and **Ned Collins** are playing a match at Easton on July 22, and **Fran Muldowney** and I will be playing our match there on the 23rd.

Sam Brown joined the open-heart surgery club with a new mitral valve installed on June 3 at the Lackenau Hospital in Philadelphia. On the 12th he left for home where he is making a fast recovery with lots of help from Natalie. He hopes to be back on the golf course for 18 holes by mid-August. The newest member for this select group is **Percy Erlich** who had a triple bypass at Brigham and Women's Hospital on July 8. He and I had the same surgeon at the same hospital four and one-half years apart. He returned home on the 14th and is impatient at what he considers a slow recovery, according to his wife. **Ben Blocker**, who told me of Percy's surgery, is leaving with his wife for two weeks in the Canadian Rockies, flying to Calgary and driving from there.

Les Brooks is practically euphoric in his enthusiasm for Rock Mart, Ga. "The longer I stay here the better I like it. There's peace and quiet, and it's so soothing to see and walk through the woods. We're constantly surprised to see new (to us) wild flowers popping up in the field and the woods. I can't grow some things here because of the heat, but others grow like crazy—no rhubarb, but corn, potatoes, yams, cabbage, cauliflower, and melons. We're drowning in squash and beans, and we picked six gallons of blackberries so far in a small patch near the creek. I've lost a lot of extra poundage and feel great."

I regret having to report the deaths of three more classmates: **Robert C. Blankenburg** of Suring, Wis., died July 1, 1980; **John Shaw Cort, Jr.** of Cleveland, Ohio, died in September, 1980; and **S. Smallwood Fox** of Jupiter, Fla., died on March 24, 1980. I am sending our sympathy to the surviving widows.

Hamilton H. Dow, with whom in earlier years I teamed for some amazing golfing victories in tournaments on both coasts, has written to tell me he has given up serious golf—now plays just for fun. His foursome on the Rancho Bernardo course includes three men in age from 83 to 87 and they have a great and relaxing time. Non-golfers are invited to write to me.—**Allan Q. Mowatt**, Secretary, 61 Beaumont Ave., Newtonville, MA 02160

36

Our 45th is now but a memory although your secretary has a wealth of information to share with you from time to time. First a few notes from some unable to be present in either Cambridge or Harwichport. **Philip Gilinson** retired from the Draper Laboratory at M.I.T. a year ago and at reunion time was giving a series of invited lectures in inertial guidance in Peking. . . . **Richmond Eddy**, according to word from his wife, having retired from the N.Y.C. Hospital Corp., is now freelancing as an architect. . . . **Tom Kato** writes from Tokyo that he is still with the State of New York, Department of Commerce, urging Japanese manufacturers to settle in the Empire State. He comments that he is well and active but has never made much money, not enough to retire or attend a reunion. . . . **Fred Prahl** expected to be arriving in Newport Beach, Calif., at reunion time. Fred retired last February as a vice president of Compo Industries in Waltham and left April 1 by motor home south to Florida, west to southern California, and eventually home via the Pacific Northwest. He should be back East when you read this.

An article in the *Fall River* (Mass.) *Herald News* describes an interesting project of Ruth and **Bob Sherman's** with an assist from their son, William.

Ruth has edited the *Journal of Minister-Farmer*, Peleg Burroughs, of Tiverton, R.I., for the years 1778-1798; Bob compiled an index and son Bill wrote the computer program for it. The work has taken some years. Bob is chairman of the math and sciences department at Bristol Community College. They live in Warwick, R.I.

Starting at the end of the alphabet I will share with you the questionnaires returned to **Laddie Reday** before the reunion. If you wish to send yours (if you didn't) it's not too late. Send it to me. **Pete Weinert**, whose last position was senior vice president, United Oil Products Process Division, writes: "Employed in the petroleum industry since graduation and I must say it has been a very exciting and challenging lifetime with travel all over the world. Now very happy that I am retired with seemingly not enough time yet to get it all done. Wonder how I managed before retirement. Have always enjoyed skiing, competitive sailboat racing and gliding and am still active in the sports." . . .**Homer Webster** writes from Hawaii where he retired after being owner of Webster Amphibious Aircraft in Seattle, "22 years commissioned service, U.S. Navy, as naval aviator. Before World War II flew sea planes launched by catapult from battleship—*U.S.S. West Virginia*—an era of naval aviation now gone forever. Retired from active service in June 1957. From 1957-1958, base manager for guided missile tracking stations in the Caribbean for U.S. Air Force Guided Missile Command at Cape Canaveral, Fla.; 1958-1964, distributor for the Northwest for Lake Amphibian; 1964 to present—living one-half year in Kirkland, Wash., and one-half year in Hanalei, Hawaii. Fully occupied in retirement living and world traveling." . . . **Mark Warmuth** checked in from Wyckoff, N.J. He is a project engineer for Englehard Industries. He writes, "Very prosaic life—nothing very interesting. Dashing (I thought) bachelor till age 40 (Boy, did that make a change!). Worked for three aircraft companies as structural engineer, for two aircraft equipment manufacturers for 12 years in various technical sales positions, as chief engineer for two years with a small specialty foundry, as project engineer for the last ten years for Rohm and Haas Co., Hess Oil, Engelhard Industries. Have been seriously unemployed and broke twice. Have attractive 21-year-old daughter who drives 400-horsepower, 18-wheel tractor-trailer rig on trans-continental runs. That's about it." . . .**Bob Wead** writes from Maui, "After 30 years in engineering, applied research, and defense marketing, I obtained degrees in psychology and counseling and began practice at assisting people to clear up problems. We have been living on Maui two years and my other interest is learning more about this magical place." . . .**Roman Ulans** has retired twice: from the U.S. Army in 1966 with the rank of colonel and as director, European Office, Communications Satellite Corp. He is living in Pipersville, Penn.

Belately, I have been informed of the death in 1977 of **Wilson A. Taylor, Jr.** He has lived in Missouri for some years and was at one time investment officer with the St. Louis Union Trust Co. His widow lives at 44 Conway Cove, Chesterfield, MO 63017.

Once agian, if you are around these parts on Saturday, October 24, wend your way to West Hartland and let **Augie** and **Virginia Mackro**, 139 Peper St., Monroe, CT 06488, know that you are coming.—**Alice H. Kimball**, Secretary, P.O. Box 31, West Hartland, CT 06091

37

William B. Bergen of St. Michaels, Md., writes, "After 30 years at what is now Martin Marietta and another 10 years at Rockwell International, retired to God's country or what is known as the 'Eastern Sho of Maryland.' Had a short stay! Rolls-Royce asked me to go to England, so we spent two wonderful years with Rolls-Royce Aero Engines in Derby. Returned to St. Michaels at the end of 1980." Bill has four adult children and three grandchildren. . . . **Norman A. Matthews** writes from Salem, N.Y., to say he retired in May 1980 from the Bureau of Mines, Department of the Interior, Washington, D. C. He has a 52-acre farm in West Hebron and finds it much work getting back in shape. He also has a few pigs and hopes to have two beef cattle shortly. He's in good health and has lost a couple of inches off the waistline. Norman has four children—Bonnie Jean Gabriel, Ringwood, N.J., who has three children; David, who is a manager of Landau Inc. stores in Manchester, Vt., and has 2 children; Judith Selund, of Gary, In., and Mark, an attorney in Clinton, Iowa. Norman is a member of Salem, N.Y., Rotary Club. . . . **Philip Bliss** retired from Pratt and Whitney, Commercial Products Division, on April 1, 1981. He is consulting and continuing work with ANSI, ASTM, ISA on national/international standards.

Charles W. Gadd of Orchard Lake, Mich., retired in 1975. Last year he and his wife Fran drove to Oregon for a get-together with other violin makers to cut Engleman Spruce trees for violin and cello making. In order to have the right grain, instrument wood has to be cut a different way than would be done by a commercial sawmill. Chuck received two awards in 1980. In Washington, D.C., he received one of four awards given by the Department of Transportation for automotive safety contributions. The other award was a first place for tone, in competition with 72 violins entered at the violin makers convention in Arizona. His wife Fran has been re-elected president of the local Historical Society. They are both interested and active in curling activities, including bonspiels in Canada and also in Minnesota. Fran represents the Detroit Curling Club on the national board for women curlers.

William B. Penn of Erie, Pa., has 40 years with General Electric Co. in Erie. At present, he is a consulting engineer with G.E. Bill is president of the Electrical Insulation Society of IEEE. He was elected a fellow in IEEE in 1975. He writes, "And I was a Chemical Engineer." . . . **Edward L. Bartholomew, Jr.**, writes from Marion, Mass., that he has retired as a professor of metallurgy at the University of Connecticut. Ed has some old records and knowledge of the Wareham, Mass., iron industry when iron was manufactured from bog iron mined from the local swamps. Recently he was interviewed for an interesting article on the subject which appeared in the *Sunday Standard Times*, New Bedford, Mass.

Loring C. Farwell, formerly of 735 Happ Rd., Northfield, IL 60093, died April 6, 1981. Loring retired in January 1981 after 26 years on the faculty of Northwestern University as a professor of finance. . . . Brigidier General **John R. Burns** died December 27, 1980. His last address was Apartment 4B, 330 Concord, Charleston, SC 29401. . . . **Francis E. Neagle**, formerly of 103 E. 75th St., NY 10021, died January 14, 1981.—**Lester M. Klashman**, Assistant Secretary, 198 Maple St., Malden, MA 02148; **Robert H. Thorson**, Secretary, 506 Riverside Ave., Medford, MA 02155

38

Our mini-reunion at Endicott House last June, attended by 46, was such a success that Prexy **Dave Wadleigh** is planning a repeat next June. Dave announced at the dinner that, instead of using amateur reunion chairmen, as we have in the past, for our 45th (1983, in case you have forgotten) we will use a professional—**Don Severance**. Don requests that if you have any thoughts as to when and where you think the 45th should be held, drop him a line.

Sid Baron writes that after two years of retirement, he has taken on a part-time position with Hydrotronics, Inc. as a consultant. Sid winters in Cypress Bend, Pompano Beach, and summers in New London. He is ready to take on all comers in golf or tennis. . . . **Harold Cude** has joined the ranks of the retired, and became professor emeritus at the University of Nevada-Reno. . . . **Hubbard Little**, in contrast to those of us who are retiring, has started a new computer software business with his son Mark. Analex, Inc. is the company in Cleveland, and it develops software for microcomputers. . . . **Charles Donlan**, who retired from NASA and Langley Field, spent over 40 years of involvement in our space exploration programs. He now lives in Alexandria, Va., and has gone on record that he would like to be a volunteer passenger on a future space shuttle flight.—**Armand L. Bruneau, Jr.**, Secretary, 663 Riverview Dr., Chatham, MA 02633

39

Five classmates sent greetings. **Gus Griffin** sold Griffin Chemical Co. in 1979, and then he developed a chrome recovery process and designed some low-cost instruments. Gus did *not* say his sensors were less expensive than a Boy Scout's wet finger held aloft in the wind or his indicators more economic than a ground hog's shadow. Gus did say he is still living with the same woman, and we hope she stimulates him to write more. . . . **Ben Howes** retired as executive engineer from Ford Motor Co. He and Anne divide their time between consulting, summering in Richmond, N.H., and caring for their fleet of Jaguars and Model A's. . . . **Hugh Kennison** retired as president and CEO of Interpace Corp. . . . **Leo Weiss** discovered the changing securities laws created a need for his new company which is dedicated to helping investors with venture capital. . . . **George Cremer**'s peripatetic postcard advised he is about to conclude journeys through Alaska and western Canada. After a brief pause at their Lemon Grove homestead, George and Billie may drive by for Hilda and me so we four can weekend at their cottage near Rosarita on the Pacific, about 30 miles south of the Mexican border. It seems to me we all have a lot of blessings to cherish, among which are friendships with classmates.—**Hal Seykota**, Secretary, 1421 Calle Altura, La Jolla, CA 92037

40

Rowland Peak writes that he retired two years ago from the Illinois Central Gulf Railroad. Although he is doing consulting work for them, he doesn't let it interfere with golf, gin, or gardening at his home in Metairie, La. . . . Another interesting note from **Robert Deshon**, who retired in May 1980 as professor of architectural design at the University of Cincinnati. After 34 years of "aligning the youth," he's now professor emeritus. Last fall Bob and his wife, Miriam, motored throughout England and Scotland, including a round of golf at St. Andrews. In February he had a quadruple bypass and is presently doing all those exercises so that he can get back on the links.

News clipping indicates that **Harold Wallace** retired this spring from the board of directors of EG&G, Inc., Wellesley, Mass.

I am sorry to report the death of **Harry E. Martin**, in November 1980. Harry had been retired and lived in Newport Beach, Calif. Unfortunately, I have no additional information. . . . **W. Kenneth Davis** sent a letter to V. A. Fulmer, secretary of M.I.T., stating that since he had been confirmed as deputy secretary of the Department of Energy, he had to resign from various positions, including his memberships on the visiting committees of civil and chemical engineering. As previously reported, Ken had been vice president for planning with Bechtel Power Corp. . . . **Al Guttag** writes that he is still working hard at patent law with Cushman, Darby, and Cushman, as well as continuing his running. In March, Al ran in the National Masters 30-kilometer race (18.6 miles) from Schenectady, N.Y., to Albany! This was the first time that there was team competition for those youngsters 60 and over. His team, the Potomac Valley Seniors, finished first!

Three of your class officers—**Jim Baird**, **Ed Bernard**, and **Don Erb**—held their second meeting on June 18 to discuss our 45th Reunion. After reviewing and visiting a few selected locations, we felt Woodstock Inn in Woodstock, Vt., would really make this a super reunion, especially since the weather has decreed that we should be rained out every fifth reunion year on the Cape! More details as they become available. Keep those notes coming.—**Donald R. Erb**, Secretary, 10 Sherbrooke Dr., Dover, MA 02030, (617) 785-0540

42

This month's column is as much a commercial for our 40th Reunion class gift as it is class news. By the time you read these notes, you may have already been solicited by your regional vice president. If, per chance, you have *not* yet heard from your vice president, *now is the time to get out an envelope, a stamp, and your checkbook and send your check.*

To make things easier here are their names and addresses: Northeast Region—**Lou Rosenblum**, 24 Cedar Rd., Belmont, MA 02178; New York Area—**Harvey Kram**, 59-25 Littleneck Pkwy., Littleneck, NY 11362; Midwest—**Dick Meyer III**, 1211 Monroe Ave., River Forest, IL 06305; South—**Hugh Schwartz**, Coca Cola Co., Foods Division, P.O. Box 3216, Forest City, FL 32751; and finally West Coast—**Jack Quinn**, 12 Samoa Way, Pacific Palisades, CA 90272. **Floyd Lyon**'s Gift Committee says that we will get a maximum number of contributors and set a new class participation record this year.

Alan Katzenstein writes all the way from Larchmont, N.Y. (the very next town from here!), saying that he has been working with **"Ty" Tyree**. Al visited Ty and Barbara in Williamsburg and says: "Ty is playing at being a curmudgeon but is really bringing the quality of an M.I.T. Course V training to bear on matters of corporate significance and of public policy." Al also reports meeting **Wendell Phillips** during the M.I.T.-New York Alumni Center's tour of The Catherdral of St. John the Divine. Finally, Al saw **Dan Hulett**, who is consulting in personnel development after retiring from Union Carbide.

Jim Stern's daughter Steffie was married in June, and M.I.T. was well represented among the guests, including **Alan Katzenstein** and your secretary from our class; Jim's brother Dick Stern, '43, and Bob Sackheim, '38. Missing was one of Jim's other brothers, Tommy, Class of 1952, who was in France. Tom is professor of electrical engineering and computer science at Columbia but also does some consulting for IBM and others in such nice neighborhoods as southern France and Italy.

Charlie Ruckstuhl has a new activity going, the Institute of Applied Resources, Inc. The Institute is working on a new major breakthrough in the computer world—the MIKROS chip, with one million operations per second at a milliwatt of power consumption. The chip is capable of emulating any other computer, using its software, and is radiation resistant. It is made of silicon on sapphire. It's smaller than a pack of cigarettes. If you want more information, write to Charlie.

Charlie attended his granddaughter's wedding last winter and is still boasting that he is the youngest grandfather in the class. His advice to all and sundry is that grandchildren are wonderful and people should have them before children. Seems a little impractical, but you all can ruminate about it.

George Toumanoff was recently elected vice president for radar and navigation of AIL Division of Eaton Corp. This involves business trips to China and the Far East. . . . In a note from **Charlie Speas** we hear that he continues to work half time as senior technical adivsor to Hedwin Corp., spending the other half arranging and attending technical conferences in Europe in the company of his travel agent, his good wife Betty. They still live in Baltimore and are planning to attend the 40th Reunion.

Further news about **Dick Hughes** reported as usual by **Jerry Coe**—Dick will probably be elected president of AIChE this fall.—**Ken Rosett**, Secretary, 191 Albemarle Rd., White Plains, NY 10605

43

Dick Feingold has risen to the challenge of researching the youth question. He finds that **Jorge Ross** of Chile is low man on the age totem pole, with a birth date of October 6, 1922. Dick still has his own turf, however, holding the title of "youngest in Palm Springs."

Sam Maloof (Course III) sends the following message on the head of a pin (anyway, the writing looks that small to me): "I have been happily and gainfully employed these past four years as a consultant in the area of environmental management. This is a far cry from my earlier professional training and experience in the area of material research. I have three grown daughters: the oldest, a lawyer in the U.S. Attorney's office; the youngest, an engineer with Mitre; and the middle daughter, two years from finishing her college education."

From the news bureau of the University of Nevada, Reno, comes the announcement that **Frank W. Bowdish** (M.S., Course III) has been promoted to the rank of professor of chemical engineering and mineral technology, emeritus. Frank was the only chemical engineer in the Mackay School of Mines when he joined the faculty in 1962. Besides building the department to its current faculty strength of four, Frank is credited with 19 years of work in the Nevada Analytical Laboratory, which serves Nevada prospectors as well as large-scale industry. He also became an important information source on traditional and innovative methods of mineral extraction in Nevada.

To you classmates who send in your news on the little cards, it would be nice to have some indication of where you're living and working. I'll certainly put it in the class notes.

I hope to see some of you at AOC in September.—**Bob Rorschach**, Secretary, 2544 S. Norfolk, Tulsa, OK 74114

44

The Technology Day program this year was most interesting and timely, one of the best in recent years. The past, present, and future problems of the automotive industry were well presented by the panel members and well explored by questions from the audience. Among those attending events for the two-day activities were **Andrew Correy**, Barbara and **Scott Carpenter**, **John Cooper**, **Jacquelyn Findlay**, **Alfred Hart**, **Robert Horn**, **Robert Jevon**, Ruth and **Norman Sebell**, **Caesar Spero**, **John Taft**, **Melissa Teixiera**, **Andrew Vallone**, and **Kenneth Young**. (In addition, your secretary was most honored to be a speaker, along with Dean Robert J. Holden and Dr. James R. Killian, Jr., '26, at the Memorial Service in the M.I.T. Chapel.)

Bob Clarke recently spent a week in June at the Hyatt Hotel in Cambridge attending an information systems conference presented by the Sloan School. Bob shared his two free nights with Boston area friends. . . . **Robert D. Arnold** writes about his role as a patent agent. So far he is his only client. In addition to his patent for a vehicle speed recorder, he has one other patent pending **Trigg Noyes** added to his alumni fund envelope, "Tried sailing with family crew of seven in British Virgin Islands concurrent with hurricane Allen which was contiguous but not coincident. Fantastic consistent breeze and friendly people." . . . Did you catch the *Wall Street Journal* for April 14, 1981, with the announcement that **Langdon S. Flowers**, formerly vice chairman and chief executive officer, was elected chairman of Flowers Industries, Inc.?

Our condolences to the widows and families of **Robert J. Estes**, who died in May 1980, and **John L. Hunn**, who died in March 1981.

Marguerite and **Ed Ahlberg**, **Andy Corry** and guest, Jane and **Lou Demarkles**, Dorothy and **John Gardner**, and Ruth and **Norm Sebell** spent a May weekend in Edgartown on Martha's Vineyard. They returned home with positive feelings about having our 40th Reunion there following activities on the M.I.T. campus. Your secretary would appreciate hearing your positive, negative, or alternative votes on this selection.—**Melissa Teixeira**, Secretary, 92 Webster Park, West Newton, MA 02165

46

The 35th Reunion was a great success. We thank **Jim Goldstein**, the reunion chairman, and his committee of **Mort Bromfield**, **John Gunnarson**, **Ted Heuchling**, **Don Hurter**, **Gene Parish**, **Bob Spoerl**, president, and **Herb Oedel**, treasurer, for doing such a grand job.

It all began Thursday afternoon, June 4, when we registered at McCormick Hall, one of the newer dorms. Buses took the class to the Symphony Hall Annex at 5:30 p.m. where we enjoyed meeting other reunion attendees. A cocktail party and a very nice roast beef dinner followed. The buses returned us to Campus for Irish coffee and some tasty desserts. **Bob Fried** made our group's Irish coffee. He really did a much better job than the bartenders. The next morning we participated in the Alumni Day affairs ending with the luncheon in the new athletic building. Howard M. Johnson, president of the M.I.T. Corporation, announced that **Angus N. MacDonald**, a director of the Alumni Asosciation and a member of the Council for the Arts at M.I.T., has been elected to the Corporation, the governing body of the Institute.

Above the head table were 14 flags representing the classes being honored—seven to the right for the most recent classes and seven to the left for the older classes. As **Howard Auerswald** pointed out, we had moved from the younger class group to the "youngest" of the older classes. So I say to you who have not attended these class reunions in the past—hurry, boys, before we are off the board. The class colors on the flag remain the same—black and blue. In the afternoon, we drove to the very lovely Woodstock Inn in Woodstock, Vt., meeting that evening for cocktails and one of the best clambakes I have ever enjoyed. Additional classmates, who could not attend the events at M.I.T. earlier, joined us at the inn.

Breakfast the next morning was followed by golf, tennis, shopping, or walking to the summit of Mt. Tom. I was one of 25 who opted for the mountain. Our guide must have thought we were Class of '76 instead of '46—he went up that mountain almost non-stop. Finally we all reached the summit, and as I crawled across the last few feet of level area at the top, I propped myself up and enjoyed the fine view, the pristine stillness broken only by the sounds of the gasping and wheezing around me. The stretcher bearers the committee had thoughtfully provided were dismissed. Word was sent down the mountain to the hospitals and infirmaries in the area that we had all arrived safely, that the medical alert was over, and that the doctors could resume their Saturday golf games. Our excellent box lunches awaited. After lunch, I chose a leisurely but longer route down which gave me the opportunity to talk with different members of the class and caused me to realize again what a remarkable, fine and interesting group of people are in our class.

In the bar at the Inn following the climb, called our Bataan March by **Mort Bromfield**, a discussion of the vertical height we had climbed occupied the conversation. By my calculation, we had climbed 9,000 vertical feet. Other class members felt the climb must have been closer to 19,000 feet. Some of the wives felt the height must have been at least 29,000 feet. The guide, when questioned, reported the climb as 900 vertical feet, but few of us believe this as we all know how Vermonters tend to understate everything.

After repairs in the bar, the class moved out to the baseball diamond for the softball game. I remember that at the 25th Reunion **Bob Spoerl** had cached his beer and other spirits but two feet past second base. His theorem was simple—very few of the class would hit the ball as far as second base and the blows that did reach second base would be so weak as to not damage the goods. And Bob was right; not a bottle was broken. At this 35th Reunion I was disheartened to see Bob place his cache only one foot past the pitcher's mound. Again that Bob Spoerl was right; not a bottle was broken. The evening ended with an excellent dinner and dance. The highlight of the evening was **Curt Canfield**'s description of his adventures at the Graduate House during the war.

Chatzy Schield's informal entertainment in song and dance routines with several members of the class was very nice. **Dan Cooper** provided a slide show and audio interpretation of photos of class members—a very nostalgic and well-presented feature. Sunday brunch at Woodstock ended the reunion with goodbyes and genuine sadness that the reunion had come to an end. Until next time—

Russell K. Dostall, Secretary, 18837 Palm Circle, Cleveland, OH 44126

48

This year's Technology Day was attended by several classmates. I obtained news from everyone but **Jim Pastoriza**, who left before I talked to him.

Jack Page has an exciting new challenge as president and chief executive officer of Vapor Energy, Inc. Vapor Energy had been one of Jack's clients in his consulting business, and he has an equity position in the company. Vapor Energy developed and is selling steam generators which make steam from natural gas without any energy going up the stack—because there is no smoke stack. The combustion gases and their BTUs are combined with the steam. Water in the jacket of the boiler is preheated, enters the combustion zone, becomes steam, and the combined gases (including CO_2) transfer heat to the point of use.

The steam generators are used by manufacturers to cure concrete blocks and reinforced concrete sections. In this application the CO_2 helps produce carbonates in the concrete which increases the strength of the part. Vapor Energy has identified a wide range of applications for their steam generators. Good luck, Jack.

Jack continues to serve the Alumni Association, and besides attending Technology Day he took part in the board meeting. Jack and Imogene visited China and were able to see firsthand how that country is changing its priorities. Jack's son had begun his investment program in 1977 by purchasing a single-family house. The investment portion became longer range when he married, asked the rentor to move, and moved into the house.

Bob Bliss and **Jackie Buck** were among those attending Technology Day. Bob is a member of M.I.T.'s Development Office and meets with alumni and other contributors to M.I.T. He recently took a sabbatical and spent three months in Mexico at a company that manufactures machinery to make shoes.

Bob's responsibilities when he was with United Shoe and Machinery included USM's shoe machine operations. Bob's trip to Mexico was arranged by the International Executive Service Corps (IESC). The company that Bob assisted was about 300 miles west of Mexico City in Leon. Bob prepared a proposal for expanding and modernizing their equipment. IESC arranges about 4,000 similar trips to assist other nations.

Graham Sterling's son Arley, who graduated from M.I.T. a few years ago, is at M.I.T. working for the Ph.D. in economics. Graham is still responsible for long-range planning at Analog Devices. The results of these efforts are quite evident from Analog's continued rapid growth. Graham has played an important roll in Analog's support of M.I.T.

Gloria and **Sonny Monosson** were at the buffet before Tech Night at the Pops. Sonny has been named chairman of the audit committee of the National Commercial Finance Conference. Also, Sonny met **Jules Levin** at the NCC show when Jules came over to Sonny's booth. Jules is doing fine and looks the same, to quote Sonny. Jules is still at Los Alamos, N.M. My recollection of my last phone call to Jules is that he was involved in computer applications for global communication of the government.

John Walch received first-place honors for his watercolor of a fall scene in New Hampshire. Besides his work at Public Service of New Jersey, John writes a column for the Power Engineering Society about the subject of senior members' recognition. John is president of Family Service of Nutley, N.J., and senior warden at Grace Church.

Dick Harris merged his company with Trans-Technology Corp. last year. Trans-Technology consists of several companies in aerospace, ordnance, infrared countermeasures, and textile and packaging machinery. Dick's company, Curtis and Marble, made a good fit with the machinery groups. Dick and Rosemary are building a house in Maine. He enjoys completing different sections and making additions to the house.

A few weeks after seeing these classmates at Technology Day, **Phil Bragar** and I had dinner in Cambridge at the Acropolis Restaurant. Phil has joined Carson Associates as a principal consultant and has responsibilities for Carson's office operations. Carson's office is near Concord, Mass., and Phil is living in New Hampshire. When Phil returned from Israel a few years ago, he tried selling products for reducing energy consumption. Gradually he moved to heating and ventilating engineering. He and his wife lived in Red Bank, N.J., when Jack Carson, whom he had known at Draper Labs, invited Phil to join Carson Associates. Phil's daughter is married, and their farm is in Maine on the Bee Line Highway between Bangor and Calais.

Karl Justin wrote recently and enclosed an article from *Baumeister*, a German magazine. The article described Karl's design for Public School 26 in the Bronx. Completion of the building is scheduled for this fall. The new construction replaces the burned-out central building and connects the remaining wings from the 1920s and 1930s. The windows are functionally designed as narrow deeply inserted horizontal slits. However, connecting vertical slits placed at selected windows at the end of the horizontal slit provides the effect of a larger rectangle to each window. The use of alternating polygonal and rounded sections help produce an optical reduction of size and integrates the building with the remaining wings. Karl is still plugging for the best of all worlds—a profit in his home town.

Lou Rasmussen, vice president of corporate planning and finance at Kansas City Power and Light, has been elected to the board of directors of the company. Lou has another achievement which somehow missed this column—he earned the J.D. degree in 1968 from the University of Missouri. Lou and his wife Cecile have four children. Lou has retained his friendly smile for which he was remembered in freshman mechanical drawing during the summer of 1945.—**S. Martin Billett**, Secretary, 16 Greenwood Ave., Barrington, RI 02806

50

We have another reply to the challenge laid down by **Ed Kruse** in April's *Technology Review*. **Donald R. Walker** reports that he has been a town meeting member in Reading, Mass., for 22 years; served on the school committee for 12 years and was chairman for seven of them; served on a town government study committee and a charter commission; and for the last 18 months has been a member of the Massachusetts Board of Education. Don says that, although all these positions have been unpaid and at times frustrating, he has generally found them extremely rewarding and a pleasant but challenging complement to business life. Also, Don knows of at least one other classmate who has had similar government experience. . . . **Ken Roberts** was a Reading town meeting member for many years and served on the school committee for six years. After 17 years with Avco, Don joined Baird Corp. eight years ago as vice president and general manager of the Government Systems Division which is involved in many activities, the largest of which includes night vision equipment and specialized electro-optical instrumentation. . . . **Paul S. Masser** is working on the shuttle and other aerospace projects at Aerojet in Sacramento, Calif. . . . **Lee S. Richardson** is now in Idaho Falls—running the Hot Cells!

Hansjoerg Stern tells us that, after five years of management duties at GE's Nuclear Energy Business Group's Wilmington, N.C., fuel plant, he has taken on a new position of consulting engineer, manufacturing technology. He also enjoys working with the Explorer Program of the Scouts as advisor to an Aviation Explorer Post. While he is working hard on his instrument pilot rating, wife Mary is active in the musical development in their area as vice president of the local North Carolina Symphony Board, the Wilmington Oratorio Society, and the music education of Karen, their 14-year-old budding virtuoso. . . . On June 1, six M.I.T. alumni were elected to its Corporation, the governing body of the university, at a meeting of the Corporation preceding the 115th commencement exercises. Announcement of their election was made by Howard W. Johnson, chairman of the M.I.T. Corporation. Among these was **Kenneth H. Olsen** of Lincoln, president of Digital Equipment Corp., who was elected to life membership. Mr. Olsen worked in the M.I.T. Digital Computer Laboratory and at M.I.T.'s Lincoln Laboratory before founding Digital Equipment Corp. in 1957. He has been a member of the M.I.T. Corporation since 1971 and is a member of its Visiting Committees for the Libraries and the Department of Aeronautics and Astronautics. He is a former chairman and member of the Visiting Committee for the Department of Electrical Engineering and Computer Science. Mr. Olsen has been honored by several Massachusetts organizations, and he received M.I.T.'s Corporate Leadership Award in 1976, recognizing alumni who head companies. he is a founding life member of the M.I.T. Sustaining Fellows and a director of the Ford Motor Co., the Shawmut Corp., and Polaroid Corp. . . . **Stephen H. Senzer** is presently co-founder and president of SABRE Association, Inc., a consulting firm with offices in Norwalk, Conn.

We were saddened to learn that **Thomas Mea** passed away in April of this year. Tom made his home in Burlington, Mass., and is survived by his wife, Audrey, and three daughters. . . . Kennemetal, Inc. of Latrobe, Pa., announced the election of **Jack C. Acton** as executive vice president, effective June 1. Jack previously had been staff executive for new business development of the Industrial Products and Components Sector of General Electric Co. Having joined General Electric in 1950 as a test engineer, he had a variety of assignments there in his 30-year experience. In addition to working with the small and medium motor department, aerospace electrical products, and housewares engineering department, he served for three years (1976-1979) as president and general manager of General Electric of Mexico. Returning to the United States in 1979, he became staff executive of technology operation for the industrial products and components sector of General Electric. He was named staff executive for new business development in September 1980. Jack's responsibilities will include executive management of the company's metalworking products, metallurgical, mining tool, and international groups, in addition to various operations support services.—**John T. McKenna, Jr.**, Secretary, 1 Emerson Place, Apt. 11H, Boston, MA 02114

53

We have a number of items this month—so many that I'm going to save some for next month. However, keep up the good work and keep the items coming. Also, remember that our 30th Reunion is only 20 months away. It's never too early to make plans, at least, put it on you calendar.

Stephen A. Kliment is in the news again. He has been named senior editor of Whitney Library of Design. He will spearhead a major expansion of Whitney's line of books in all areas of design, including architecture, urban, landscape, interiors, industrial, graphics, and transportation. He has authored a number of books and operated his own editorial and graphics consulting firm since 1972. Stephen lives with his wife and two daughters in New York City.

Gerry Langelier of Qunicy, Mass., has been appointed technical director of the Aerospace Surveillance and Defense Division at the Bedford operations of Mitre Corp. Gerry will be overseeing Mitre's efforts as system engineer on the Air Force E3A Airborne Warning and Control System (AWACS). I had the pleasure of working with Gerry's brother in the Department of Defense a few years ago.

John F. Batter has been named vice president of the design engineering and support department for Xerox Corp.'s Reprographic Technology Group. John joined Xerox in 1974 as an assistant group program manager and worked his way up through group program manager and then manager of the RTG technical staff. John has written about 25 articles in the field of mechanics and nuclear physics. He lives with his wife and four children near Rochester, N.Y.

And finally, **Gene Richter** writes that he is teaching evenings at a local Cleveland business school, to help carry the load of four children. He doesn't say what he does in the daytime. His daughter Wendy attends Dartmouth and is currently in France, while Heath, 17, is abroad this summer on the "Experiment in International Living." Blossom, 10, and Rick, 6, are satisfied to stay at home and keep Gene and his wife Jenifer rather busy. Gene used the word *hopping*, and you know what they say about bunnies.

Well, that's enough of the terrible humor (who led him to believe that that was humor). Keep the items coming. Please note the address change. The Gardners are moving again.—**Gil Gardner**, Secretary, 3400 Rusticway Lane, Falls Church, VA 22044

54

Question: Which member of the Class of '54 won an Academy Award? *Answer*: **Alex Dreyfoos!** We are indebted to James Torbit, '31, secretary of the M.I.T. Club of Palm Beach County, for bringing this fact to our attention. The award was made in 1971 (good news travels slowly) for a motion picture version of the video color negative analyzer, which was invented by Alex and his associate George Mergens. The VCNA is used in photographic laboratories for viewing a color negative as a color positive on a TV screen in order to determine how the negative should be printed to get optimum quality. The VCNA is manufactured by Photo Electronics Corp. (PEC), of which Alex is chairman, and is marketed worldwide by Eastman Kodak Co. Alex also runs WPEC, the West Palm Beach TV station which is an ABC affiliate, the Sailfish Marina, and the Laser Color Corp. The laser color printer (another Dreyfoos invention) compensates for the biases inherent in color slides and makes true-to-life prints. Alex is also involved in numerous civic and cultural activities in south Florida. He was a founder and the first chairman of the Palm Beach County Council of the Arts. Last year he was named Outstanding Citizen of the year in Palm Beach County. In January the *West Palm Beach Post* named him Business Leader of the Year. In addition Alex, a loyal son of M.I.T., is a member of the M.I.T. Corporate Development Board.

Well done, Alex! We take vicarious pride in your many accomplishments and feel privileged to be your classmates.

The Class of '54 recently had an unusual problem: what to do with excess funds in its account? At the suggestion of **Robert Evans**, our class treasurer, a gift of $5,500 was made to M.I.T. in honor of Paul Gray's inauguration, to be used at Paul's discretion. The result? A grant to Professor Heather N. Lechtman to support her efforts as head of the Institute's Center for Materials Research in Archaeology and Ethnology. Also, any rich, old ethnics out there should note that Professor Lechtman can use additional support.—**William Combs**, 120 West Newton St., Boston, MA 02118; **John Kiley**, 7 Kensington Rd., Woburn, MA 01801; **Louis Mahoney**, 52 Symor Dr., Convent Station, NJ 07961; and **Dominick A. Sama**, 28 Chestnut Hill Rd., Groton, MA 01450

55

Fall is a time regarded by many parents with mixed feelings. While the children are now off to school, it is necessary to pay the schools to take them. Those of us who had the opportunity but declined to sell our children at an early age to riverboat captains are now paying dearly for that little conceit.

Paul Mosher wrote an interesting letter about his new assignment in London. He is the senior vice president for international operations of Kelco, a subsidiary of Merck and Co., Inc. In his new position he is responsible for integrating Kelco's international operations with Alginate Industries, Ltd., a company acquired last year to form an international business. The two firms have product lines of carbohydrate polymers that are used to stabilize water-based systems for the food, textile, paper, and oil-well drilling industries. Paul and Wanda have a flat in Knightsbridge, around the corner from Harrod's, and they are looking forward to seeing as much of Europe as possible. Their son Peter is joining them as a student at Ithaca College's London campus, while daughter Kathryn continues her education in San Diego. In a couple of years when the business consolidation is complete, the Moshers expect to be back at Kelco's headquarters and their home in San Diego.

John Gahran has expanded the activities of his management consulting firm to include clients from Canada and Mexico, as well as the U.S. Among his clients are fellow M.I.T. alumni who own their own businesses. His daughter Lynn graduated from St. Joseph's University and is entering law school, while daughter Ann is a freshman at the University of Pennsylvania, aiming at a business career.

In a recent announcement of commercial property sales, **Zaven Dadekian** was reported as the new owner of Cushing Plaza, a shopping center in Cohasset, Mass. Zaven, who has substantial real estate holdings in the metropolitan New York area and the southern U.S., stated that he intends to maintain and improve Cushing Plaza, ". . . as my way of affirming an attachment to the area which I will always maintain."

One of our class members who enjoys the respect and admiration of the residents of his town is **Sherman C. Reed**, who ran for the office of selectman in Orleans, Mass. Sherman moved to the town after his career with the Navy, which began at the Naval Academy and ended with the Meritorious Service Medal for managing the Navy's ship design program. He served on town committees to codify bylaws and study traffic, and as the Republican party chairman of Orleans. He also led the successful drive to establish the Cape Cod Rail Trail bicycle path along an old railroad right-of-way.

Edwin A. Chandross has been named head of the Organic Chemistry Research and Development Department of Bell Laboratories in Murray Hill, N.J. In his present position, he will be responsible for managing research in organic chemistry. This includes such fields as reaction mechanisms, photochemistry, and organometallic chemistry. After M.I.T., Ed received his M.A. and Ph.D. from Harvard and joined Bell Labs in 1959, where his primary responsibility was research in organic and physical chemistry. He has received 20 patents and published 70 articles on his work on chemiluminescence, photochemistry, photosensitive materials, and thin-film optics. He is a member of the American Chemical Society, the Chemical Society (London) and the American Association for the Advancement of Science, as well as the editorial board of *Chemical Reviews* and the executive board of the Inter-American Photochemical Society.

A sad duty of your secretaries is to report the death of **Winston Alva Cartledge**, who suffered a heart attack on April 19, 1981. Winston was a kind and gentle person. You may wish to extend sympathy to his mother, Mrs. Ralph S. Cartedge, 1171 E. Rock Springs Rd. N.E., Atlanta, GA 30306.—Co-secretaries: **Marc S. Gross**, Winding Road Farm, Ardsley, NY 10502; **Allan C. Schell**, 19 Wedgemere Ave., Winchester, MA 01890

56

This year marks the fifth quinquennial of the graduation of the Class of 1956. To celebrate this occasion, nearly 150 class members, accompanied by sundry companions and offspring, returned to the Institute for four days in June. The 25th Reunion entailed numerous activities. The recounting of these activities will however have to be relegated to subsequent issues.

Your new eastern secretary would like to make a proposal to the class, and that is that we use these notes for some additional purpose to being the class gossip column. May I suggest to my esteemed classmates that this column could also be used to exchange views of the members of the class on specific issues of the day? I would have a lot more fun if I could generate a number of running polemics.

The next couple of editions of these class notes will be dovoted to the 25th Reunion. What they will contain after that will depend on your response to my proposal.—Co-secretaries: **Robert Kaiser**, 12 Glengarry, Winchester, MA 01890, (617)729-5345; **Caroline Disario Chihoski**, 2116 W. Davies Ave., Littleton, CO 80120, (303)794-5818

57

Paul Nicholson, our erstwhile president, has announced the chairmen of our 25th committees. **Jordan L. Gruzen** is serving as chairman of the 25th Gift Committee and **William H. Doughty** as 25th Reunion Committee Chairman. Jordan is chairman of Gruzen and Partners Architects with headquarters in New York City and an office in San Francisco. At M.I.T. Gruzen and Partners developed the master plan for East Campus and are principal architects for both the new Whittaker College of Health Sciences, Technology, and Management and the M.I.T. Medical Department building. He lives in NYC with wife Lee, daughter Rachael, and son Alex, who has just completed his freshman year at the Institute. Bill Doughty is principal environmental and safety engineer at Polaroid, Cambridge. He is past chairman Boston Section, American Institute of Chemical Engineers, and lieutenant colonel, U.S. Army Reserve. Bill and his wife live with their two children in Wayland, Mass. Paul states further in his announcement, "Both of these gentlemen have demonstrated a long and illustrious record of contributions to M.I.T. and class activities. I trust that they will receive the full cooperation of the class in pursuit of their duties. Further correspondence concerning gift and reunion activities will come directly from the new chairmen."

Course notes offered this summer included two on decision analysis taught by Dr. R. L. Keeney and Professor **Alvin W. Drake**. . . . A Lear Siegler press release announced the appointment of **Lowell E. Wilson** to the newly created position of corporate director, facilities planning, for LSI, Inc. Congratulations and good luck! . . . **Ed Friedman** forwarded an attractive brochure describing a series of six public lectures on technology for the non-technologist that he gave at Iona College where he is dean of the College Stevens Institute of Technology. . . . **Dominick Fortunato** writes that he has returned to Burns and Roe, Inc., and is now working on DOE's conceptual design study for a breeder reactor plant. . . . **John A. Collins** tells us of his travel plans during his leave of absence from Hughes Aircraft. Along with his wife Lois and son Patrick, he is taking his 36-foot sloop *Sundowner* for extended cruising, including the Channel Islands, then north along the California coast, returning in the fall to Los Angeles, then to Mexico in December, and on to Hawaii in May of 1982. Utopia, here we come!!!

A note written back in March from **Joseph J. Carty** catches us up on his whereabouts. He moved to Tokyo in July 1980 as manager of commercial analysis for IBM Asia Staff Operations. His family includes Jim, a sophomore at Duke studying electrical engineering; Tom, a junior, and Sara, a sophomore, at American School in Japan; and Matt, a fifth grader at Nishimachi International School. He and his wife Jane are enjoying Japan thoroughly and expect to remain there for two or three years. I will look Joe up when I am in Japan in August and report back next issue.—**Fred Morefield**, Secretary, Shared Medical Systems Corp., 650 Park Ave., King of Prussia, PA 19406

58

Summertime this year was anything but easy living for Beth and **Al Russell**. In early June their son David graduated from M.I.T. and then moved to New York to attend Cornell Medical School. Then, their daughter Lisa was married in Amherst in late June. This occasion also brought together several of Al's Phi Mu Delta fraternity brothers including **Joel Shulman**, **Bernd Gunther** and **Mike Brose**. Joel is still in New York City with IBM World Trade and is living in the Village. Bernd, along with his wife Mary, is an active sailor on weekends, and during

the week he is at Thermo Electron Corp.

Michael Gottelieb has been appointed managing director of the Mektron Europe Group of Rogers Corp. He will have responsibility for all of Rogers' Mektron operations in France, Germany, and Belgium. Mike lives in Kraainem, Belgium, and is a founding member of the International Club of Brussels. . . . Gloria and **Mike Kenyon** spent several weeks in Costa Rica visiting one of her relatives. Much of their time, Mike writes, "was spent close to Golfita, about 200 miles south of San Jose. This is United Fruit's main banana growing region in the country, and we studied the area with the help of one of United Fruit's agronomists."

Another book is due from **Daryl Wickoff** in the spring. Entitled *The U.S. Lodging Industry*, it examines the structure, development, and growth of this rapidly changing business. In addition to serving on the boards of Victoria Station and Charles River Associates, he is now on the board of Midway Airlines. And just to keep from being bored, he also serves on the board of trustees of the Winsor School in Boston. . . . **Thomas Blood** is now a senior partner in the architectural firm of Blood, Houghton, Huges, Architects. Their firm has grown to a staff of over 30 professionals and they have offices in Montreal, Ottawa, and Toronto. Tom's son Stephen graduated from Wesleyan University this past June, and another son, Christopher, is a senior at Queens University this year. . . . **Ray Hybarger** has joined a new company, Fermenter Corp., as manager of biochemical engineering. The firm specializes in fermentation systems for converting grain or waste products, including cheese whey, into fuel alcohol. . . . **Elizabeth Drake**, a vice president at Arthur D. Little, Inc., was recently elected to the M.I.T. Corporation. She is also a member of the Corporation Visiting Committee for the Department of Chemical Engineering and serves as alumnae corporation president for the Women's Independent Living Group. . . . Still waiting by the mailbox at the end of the lane for more of those "wish you were here" vacation postcards telling me all about your latest doings.—**Michael E. Brose**, Secretary, 59 Rutland Square, Boston, MA 02118

59

I must be doing something right—this is the second month in a row that I have plenty of news to fill a column.

The first note is from **Bruce Blomstrom**, who has just returned from four years abroad as general manager of Abbott Laboratories companies in South Africa and Japan. He writes that he is now director of corporate planning and development in Abbott's north Chicago headquarters. There is no indication whether or not he is glad to be back. Having lived in Japan for several years myself, I am sure he returns with mixed emotions. . . . **Paul Weiser**, Course III, writes the following, which I am quoting in its entirety: "Senior vice president, secretary and corporate counsel of Dataproducts Corp." . . . **Glen Zeiders**, Course II, writes, "I'm moving to Israel in June to help a new company there produce high-power metal-working lasers for cutting, welding, and heat-treating. Not wanting to be the typical U.S. traveler, I am trying to learn the native language, but Hebrew is damned hard (especially for a dyed-in-the-wool Anglo-Saxon Catholic). I've visited there once so far, like the people, and am looking forward to it." I always knew those mechanical engineers had a way with words!

The Wall Street Journal contained a brief announcement that **John Poduska** (Course VI), who is president and chief executive officer of Apollo Computer, Inc., was elected a director of Safeguard Business Systems, Inc. a supplier of information services to small business. I think I'll send him **Paul Weiser**'s address. . . . **Richard Gurski** (Course II) writes that he is now president of Hycomp, Inc., which is a manufacturer of custom thin-film hybrid microelectronics located in Sudbury. . . An interesting note comes from **James Rhodes** (Course XVI). He writes that he has left Draper Lab with a small group and has formed ITP Boston, Inc. This company provides computer control for manufacturing and has its office in Cambridge with branches in Detroit and Milan. Sounds like a great start!

James Rogers (Course XVI) has received his Ph.D. in engineering from UCLA. . . . Course II must have had a drive to send in news, because both **William Slager** and **Andrew DeStena** have written. Bill has joined HDR Sciences, Santa Barbara, Calif., as manager of the analytical support section within the Advanced Systems Planning and Technology Department. On May 1 Andrew was elected president and chief executive officer of Energy Plant Constructors (Houston), a 100 percent owned subsidiary of Foster Wheeler Corp. EPCI handles openshop construction for the process and utility industries, according to his note. . . . A press release from the National Gallery of Art, Washington, D.C., noted that **Jonathan Lane** (Course IV) has been awarded a fellowship for 1981-1982. Jon, an architect with his own firm, will complete research on a study in modern urban development entitled, "The Pattern of Suburban Growth in the United States." This study forms a part of his projected history of suburban residential architecture in the United States, from 1870 to 1940. . . . **Bob Rosenfeld** (also Course II) called late one evening to chat briefly. He, Linda, and their younger son were passing through Stamford on the traditional junior-senior summer trip (that is, visits to colleges and universities). Bob is still with Consumers Power in Jackson, Mich., and still shoots a mid-70s game of golf.

Thanks for sending all the news. If you really want to make me ecstatic, add some personal words to the promotions and moves! It may take some time, but it will get into the column.—**Larry Laben**, Secretary, 310 Rockrimmon Rd., Stamford, CT 06903

62

While in Boston in June, I visited **Joe Perkell** in his mysterious laboratory at M.I.T. Joe recieved his Ph.D. in 1974 and is a research scientist with the Speech Communications Group of the Research Lab for Electronics. He really enjoys his work, which is sticking wires on peoples' lips and tongues and recording their mouth movements during speech. I cleverly proposed an early lunch before he asked me to sit down. . . . **Gordon Mann** and his family have returned after four years in Belgium. They now live in Hudson, Ohio, where Gordon is director of world-wide product management for Eaton Corp.

Marvin Richman writes that he is now president of Olympia and York California Equities Corp., a California real estate development company based in Los Angles. . . . **Raymond Rink** is up north of most of our readers. He is a professor of electrical engineering at the University of Alberta and a "spare-time" (all of it!) sheep farmer" near Stony Plain, Alberta. . . . **Roger Rowe** recently joined Interad Limited as operations manager. Interad manufactures advanced radio communications equipment for selected clients. He and his wife Suanne have three children and live in Rockville, Md. . . . **Neil Weatherbie** has been selected for promotion to colonel in the U.S. Air Force and began attending the Air War College at Maxwell AFB, Ala., in August.—**John E. Prussing**, Secretary, 2106 Grange Dr., Urbana, IL 61801

63

Another month with a long, newsy letter from one of our classmates! I do believe you are discovering the long, lost art of letter writing, and I love it. Or is it fear of seeing fillers in this space with lies about my fishing prowess? Whatever the motivation, my correspondent this month was **Don Joseph**. Don admits that he has not been an outstanding contributor to the class notes section—this is his first letter to a class secretary in 18 years. His note mentions his year of research at Fairchild Semiconductor, his year in the Peace Corps in Ghana teaching physics and math, followed by law school at the University of Pennsylvania. Don then clerked for a federal judge in Maryland and later joined the firm of Wolf, Block, Schorr and Solis-Cohen in Philadelphia. His legal specialty is commercial litigation with efforts to use his scientific training in the areas of antitrust, environmental, and patent law. Don is married and the proud father of a 14-month old. He says he would like to be remembered as one of the three seniors on our winning basketball team at the Institute during our senior year. (Trivia quiz, designed to stimulate some letters—write with the names of the other two seniors and win a prize.) As an interesting little anecdote, Don reports an incident which I'm sure many of us have experienced. He had the fortune of meeting a client in a corporate setting and identifying him by his brass rat. However, he proved how many years he had been away from the Institute by telling him he had majored in physics, Course VI! The client, of course, was most forgiving when Don subsequently came up with the correct Roman numeral. Many thanks for the letter. Don would like to hear from other classmates. His business offices are in the Packard Building, 12th Floor, Philadelphia, PA 19102.

Ron Rothchild also wrote a letter, in which he informs us that his son Joshua Ben, a kindergartener, has announced that he doesn't want to be an engineer. Daughter Natasha Anna, now 3, hasn't made up her mind about that, but she knows she wants to be bigger than she is now. Ron's wife, Nancy, on edge after months of laboring with a fledgling company in her basement, is delighted with her new office four miles from home.

This is a good month for class news, because I'm just getting to the Alumni Fund flaps and press releases, from which we learn that . . . **David Kelly** will be visiting associate professor of business at the University of North Carolina next year. . . . **David Clapool** spent two years in Brussels as product manager for Ethyl Corp. He writes that Brussels offers many opportunities for travel, language, and the development of an international perspective on life and business. His best experiences have been with his ex-secretary and new bride Caly (Carolyn Ward), who represents all the best virtues of her English ancestry. (Congratulations on the May 23 nuptials.) . . . **Michael Lukas** and his wife, Marjorie, and their four children, have lived for the last seven years in Eastlake, Ohio, a suburb of Cleveland. Recently Michael was promoted to manager of the Development Engineering Department at Bailey Controls. He has responsibility for the development of Bailey's new microprocessor-based industrial control system, Network 90. . . . **David Marks** writes that while planning the construction and design of his house on the beach near Orient Point, Long Island, he discovered **Bruce Anderson**'s great source book, *The Solar Home*. David is also still working on sinusoidally controlled variable frame rate movies and says that anyone interested should write him for details. . . . **Raymond Regan** received his juris doctor degree from Franklin Pierce Law Center in Concord, N.H. Commencement was last May 9. . . . **Ron Matlin**, along with two other M.I.T. alumni, is a principal in TriSolarCorp of Bedford, Mass. The firm designs, assembles, and sells photovoltaic systems as turnkey installations or complete user-installed systems. Projects the company is engaged in include the construction of prototype photovoltaic systems for residences in the Northeast, and the manufacture of small photovoltaic water pumping units for developing countries in Asia and Africa. . . . Finally, a news article tells us that **Peter Rhines** was elected to the National Academy of Sciences. Peter is a senior scientist at the Woods Hole Oceanographic Institution.

This has been a very busy summer for Barbara and me, but we have managed to take some time off. We spent the July 4th in the Sierras at Mineral King. From where we were camped we could see the sun going down over the Great Western Divide, and the alpenglow kissing the crest of Mount Whitney. With a pan full of trout frying on the stove, and more jumping in the lake below us, it was the kind of thing you see in travel films. We liked it so much we are going back the first week of August.—**Mike Bertin**, Secretary, 18022 Gillman St., Irvine, CA

64

Greetings '64! Your inputs have picked up, but not much. Here's some news via press releases, news-

paper clippings, and those wonderful alumni fund envelopes (the telephone squad got me again this year!).

Data General Corp. has established three business divisions. **Lawrence Seligman** is general manager of the small business systems division. . . . Lieutenant Commander **Allen Wirzburger** has returned from a deployment in the Mediterranean Sea on the aircraft carrier *U.S.S. Saratoga*. . . . **John Miller**, bassoonist with the American Reed Trio, presented a memorial concert to the late Professor Shackford of Connecticut College last April. Miller is principal bassoonist with the Minnesota Orchestra and an instructor at the University of Minnesota.

Donald Mided is president of the family businesses, wholesalers of Oriental, Latin and other exotic fruits and vegatables. Don says, "This is probably the least technological career of any member of the Class of '64, but even here technology is making inroads and I am making some use of my M.I.T. education." He is in the final phase of development of custom minicomputer software for the produce industry and should be marketing it sometime this summer.

Ivan Johnson spent three years in Torino, Italy, working on industrial automation. While in Italy, Ivan climbed the Matterhorn, Mont Blanc, and Mont Rosa. He is presently Fiat projects manager at CADL. The Johnsons have a 19-month-old son, Erik. His wife is studying for her Ph.D. at Boston College.

Classmates, that's all the news we've received for the past two and one-half months! If we don't hear from you, we can't write a column. (No news equals no column!)

The Schlosser family has had a very hectic but pleasant spring. Weekends on end have brought guests from out of town, friends from Boston, family from New York, and family from Florida on the way to Maine. One weekend Marlene and I escaped together (sans children) to the Amish country (Lancaster, Penn.), a beautiful, peaceful, restful, and very accommodating place.

Gary Walpert and family visited the Washington area. Gary and Ellen have recently bought a new home (congratulations!) in Weston and will be moving this summer. We hope to visit them during a two-week jog around New Jersey, New York, and New England. Tell you more about it next time. Please write!—**Steve Schlosser**, Secretary, 11129 Deborah Dr., Potomac, MD 20854

65

Carol Van Aken is still with the Office of Sponsored Programs at M.I.T., now as director of special projects. Her husband Peter is a vice president at Brandeis. They have two children. Christy is 9 (I think), and David is almost 2. Carol threw a surprise birthday party for Peter a few weeks ago. The "cover" was getting Peter and the rest of the family to a reunion of Christy's preschool at Brandeis. Among the other guests at the party was **Dave Driscoll**, a former co-worker of Carol's at M.I.T. I have a press release announcing Dave's appointment as vice president for financial operations and treasurer of the Charles Stark Draper Laboratory (the old Instrumentation Lab). Dave has been treasurer of Draper Lab since it was separated from M.I.T. in 1973. He and Sheila are neighbors of the Van Akens in Winchester.

I have a note that Julia and **Dick Tsien** had a baby daughter, Sarah Tsien-Shiang, last July (1980). . . . **Dan Diamond** has joined NEC Information Systems in Lexington, Mass., as marketing manager for personal computers. . . . **Robert Silverstein** writes of an extremely interesting six months late last year. He was corporate vice president for market analysis at Northrop Corp. and director of the Northrop Corp. Analysis Center, a corporate and foreign policy "think tank." In November he became part of the Reagan/Bush transition team for the Defense Department and CIA. The Silversteins went to England last summer and are planning for the Bar Mitzvah of their son Seth in November. . . . **Peter Brown** writes that after spending nine years with various companies trying to upgrade rapid transit equipment, he achieved a modest success by assisting in the opening of the Atlanta Rapid Transit System. Peter is now a project engineer with the Navy's Fleet Modernization Program. . . . **Terry Riley**, wife Charlene, and their two children are living in London where Terry is working on the European launch of Kodak's new high volume copier. . . . **Barbara** and **Harry Vickers** are enjoying life on 15 acres in beautiful New Hampshire. Barbara is primarily involved in keeping everything running, with Paul, 13, Bill, 5, and Brian, 2. Harry recently became vice president for engineering at Intertel in Andover, Mass.

Michael White is still associate professor of public administration at the University of Southern California. He is also review editor of the *Public Administration Review* and adjunct professor of public health at the college of Osteopathic Medicine of the Pacific. He was a co-editor of *Cases in Public Management* and co-author of *Managing Public Systems*. . . . **Jim Sprinkle** is an associate professor of geology at the University of Texas at Austin. He says the undergraduate department is overrun with 650 geology majors and he reminisces about graduating from Course XII with one other classmate. Jim is assistant chairman of the department each spring. Gloria is now working for Women in Apprenticeship Programs, Inc., a service organization that locates blue-collar jobs for women. Their children—David, 7, and Xochi, 4—are both in school now. . . . **Bill Samuels** is still single and has just started (as a venture capitalist, if I recall) a consulting group in West Africa and a company using an experimental process to grow tomatoes and cucumbers indoors. . . . **Jesse Lipcon** is in the next building from me at Digital Equipment's old mill in Maynard. He is involved in the engineering of Digital's new terminals and small computers.

Keep those cards and letters coming folks.—**Steve Lipner**, Secretary, 6 Midland Rd., Wellesley, MA 02181

66

Our 15th Reunion was held in Boston June 4-7. **Stu Vidockler** was in charge of organizing the activities and did a fantastic job. An outdoor dance on the plaza in front of the new athletic center provided a most enjoyable Friday evening and set the tone for the weekend. On Saturday brunch in the Hancock Tower was followed by a day trip to Salem and a formal dinner at the Science Museum. On Sunday Elisabeth and **Dave Mundel** opened their home to the class for a farewell brunch.

At the dinner Saturday night, class elections were held. **Stu Vidockler** was elected class president. Our vice-presidents are: **Mike Kinkead**, **Paul Rudovsky**, and **Fred Webb**. Our class agent is **Larry Schwoeri**, and the assistant agent is **Jim Edgerton**. **Bill Kosinar** was elected treasurer, and **Joe Shaffery** is the new class secretary.

There were over 100 people at the reunion and we are still compiling the news which was exchanged. Our next column will contain those items I was able to glean at the reunion. All of you are invited to provide news of your activities as often as you please. I will do my best to publish all that is sent in. **Eleanor Klepser**, our previous class secretary, provided me with her inventory of news since the last issue.

Karen and **George Friedman**, now live in Cherry Hill, N.J. George is a software systems engineer with RCA, Camden. They are off camping on a seven-week trip to California through the national parks. . . . **Thomas** and **Linda Skinner** sold his security business. He is now teaching computer science at Boston University and finishing a Ph.D. thesis on computer applications to cardiac problems. . . . **Mel** and **Jacqui Garelick** left their family business. He is now working at Hamilton Standard, Windsor Locks, Conn. He is still in aerospace. They have three children, daughters, 6 and 4, and a son, 2.

James Lanyk is married, has four children, and is working as senior mud engineer for Drilling Mud, Inc. . . . **Charles Sutter** is practicing pulmonary medicine in Napa, Calif. . . . **Joseph Bravman** writes to say he enjoyed the reunion and to announce his marriage to the former Ellen Bolts on July 12, 1981. . . . **Gordon Smith** is serving as associate secretary to the Cabinet of Canada. . . . **William Del Hagen** has become a partner in Kirtland and Packard, a Los Angeles law firm specializing in aviation law. . . . **Richard Millman** has moved to Michigan where he will head the mathematics and computer science department at Michigan Tech.

Jon Meads is enjoying life in Portland, Ore., and is a manager for an electronics firm in the area. . . . **Charles Erdelyi** is an advisory engineer for IBM in Burlington, Vt., designing advanced VLSI circuits. . . . **Charles Epps** is now in-house counsel for Rolm Corp. in Santa Clara, Calif. . . . **Martin Krone** is living in the San Francisco area and working for BNR, Inc. (Northern Telcom's R&D subsidiary).

Terry May is living in the Los Angeles area and has changed jobs. He is now vice president of Bakshi Productions, a film producer.

Reunion news will be in the next column. Please write.—**Joe Shaffery**, Secretary, 34 Hastings Dr., Fort Salonga, NY 11768

67

Put the weekend of June 11-13, 1982, on your calendar and count on a good time at our 15th Reunion. Guaranteed. Activities are being planned for Friday night, all day Saturday and part of Sunday (brunch). Saturday night will be left free for "private" reunions. Why not encourage classmates in your course and dorm/fraternity to attend? **John Rudy** reminded me that we had 91 classmates at our last reunion, a record—let's set a new one in June. Incidentally, your check for class dues in the amount of $7.50 payable to the "M.I.T. Class of 1967" should be sent to John at 20 Heritage Dr., Lexington, MA 02173. . . .**Ed Geltman** has been elected to fellowship in the American College of Cardiology. He is currently professor of medicine and radiology at the Washington School of Medicine and medical director of the Cardiac Diagnostic Laboratory at Barnes Hospital. . . . **Dean Hall** is now a superintendent with Inland Steel's Indiana Harbor Works. . . . **Chuck Kolb** has been appointed vice president and director of the Applied Sciences Division of Aerodyne Research. . . . Carol and **George Starkschall** have moved from Chicago to Kansas City, where George has accepted a faculty appointment in the Department of Radiation Therapy at the University of Kansas Medical Center.

At last word **Richard Cunningham** was expecting the arrival of his seventh child. . . . **James Triant** was recently voted most outstanding instructor at Harvard School of Dental Medicine. . . . **Wayne Porter** reports that he recently performed a mid-life career change—he switched from systems analysis for Honeywell to starting his own business as a certified financial planner. Wayne lives in Reston, Va. . . . **Stephen Holford** has recieved his fourth M.I.T. degree. Is this a record for the Class of 1967? Stephen is married with three children (11, 7, and 2 years). He is working in Boston as a bioengineer doing research in physical mechanisms and diagnostic uses of lung sounds. . . . I received a letter from **Jim Dotson** in Algeria. He is working for El Paso LNG Service Co. at Algeria's Arzew LNG Complex. Jim, his wife Sarita and their 2-year-old son Arun enjoy the climate and excellent travel opportunities.—**Jim Swanson**, Secretary, 878 Hoffman Terrace, Los Altos, CA 94022

69

I'll tell you about our 12th Reunion next issue. Meanwhile, a few figures about the class. Alumni records show that 927 members graduated in the Class of 1969. Six are deceased, and I have addresses of 850 of us. We have two birth notices this month (a year late, but the first I've heard). Amy Partridge was born last June and is living in Poughkeepsie where her father **Richard Partridge** is a computer engineer designing large scale processors for IBM. Also born a year ago June is Patrick, son of **Chris Ryan**. The construction company that Chris founded in Pittsburgh last year now has an office in Dallas, and they are looking for additional

locations. The company has completed jobs in about half of the 50 states, and they recently used **Sandy Randall**'s firm, Thames Valley, as structural consultants on one of their projects.

Peter Kleeman spent the last two years doing energy policy modeling at the Brookhaven National Laboratory in New York and is now seeking a job in academia. . . . **Larry Lewandowski** is currently the president of J.D. Mullen Co., a chemical distributor in Denver. . . . Last August **Marc Davis** and Nancy Turak were married in the M.I.T. Chapel. After seven years at Harvard, Marc is now at the University of California, Berkeley where he has tenure in the Department of Astronomy. . . . **Tony Lima** received his Ph.D. in economics and is now an assistant professor and director of the Center for Economic Education at California State University in Hayward. They are "dedicated to infiltrating grades K-12 curricula with economic concepts." . . . Working as an optical engineer at GCA/Burlington Division, **Bruce Heflinger** spends weekends as a minister-in-training for scientology in Boston, which allows him to help others achieve the same gains in self-assurance he achieved via scientology back in 1977.

Carl Buzzuto is now director of advanced systems and technologies in Combustion Engineering's Fossil Power Systems Research and Development Department. More important, the Buzzutos are now up to five, with Sally Ann, their third, born last December. . . . Finally, **Paul Kinnucan** has been appointed associate editor of *High Technology* magazine, a new periodical published in Boston but with nationwide distribution. . . . I have just started swimming again, after a lapse of about eight months from almost any sort of exercise. Let's see if I can lose some of the weight I've gained and get back into some sort of condition. Times like this make you realize that it really does make more sense to just stay in condition and not have to go through the agonies of getting back into shape every year or so. (It sure gets a lot harder as we get older, too!)—**Robert K. Wiener**, Box 27, M.I.T. Branch, Cambridge, MA. 02129

71

Jay Goldman married Marianne Doernisin and bought a home in Wellesley, Mass. After working for the Institute for a few years, he is now working for Prime Computer. He is still trying to play hockey and has decided to like winter by skiing. . . . **Dale Zellers** is back in Colorado and, as chief engineer for a small firm, is designing ECG equipment. In his spare time he grows vegetables, takes pictures, and adds to a home computer. . . . Fred Stamberger, '68, solved the missing pledge problems. **Bill Ihrie** is the missing Delt pledge—my apologies to Bill for forgetting. . . . **Gary H. Lantner**, Esq., has left Continental Airlines where he served as director of properties and buildings and has advanced to director of properties and administration, Host International, Inc., the leading airport and restaurant chain based in Santa Monica, Calif. . . . **William H. Rastetter** has been promoted to associate professor at M.I.T. His research is in the area of synthetic organic chemistry, in particular the total synthesis of natural products or their analogues and of compounds which mimic biosynthetic intermediates. He received his M.A. and Ph.D. degrees from Harvard and was appointed assistant professor of chemistry at M.I.T. in 1975.

James DeLucas writes: "I have enjoyed three years at Eglin AFB Hospital as a resident in family practice. My wife Emma, my son Larry, and I have bought a beautiful colonial home on the Saranac River in Plattsburg, N.Y." . . . **William P. Mammen** is a partner in the architectural firm of Reynolds and Mammen, Architects, Park City, Utah. . . . **Jerry S. Greer** has recently become the manager of economics and regional planning at Charles T. Main, Inc. He also announces the birth of a son, Jared Scott Greer, on February 9, 1980. . . . **Paul Palmer** writes: "I am nearly finished with my 50-foot Ketch *Lau Eng*. I hope to take off in the summer of 1982. I plan to sail around for at least ten years, living off my savings and consulting when the savings run dry. The sailing pavilion should post a sign over its entrance: 'Caution—sailing may lead to uncontrolable urge to build a boat.' **Peter Hwang** married Nancy Rayburn on April 28." . . . Vicki and **Mike Oakes** came by. They look great and have three beautiful children. . . . Please tell me about the reunion!—**Hal Moorman**, P.O. Box 1808, Brenham, TX 77833

72

Lee Brown finished his second year of a fellowship in pulmonary medicine in June and is moving back to "New York and culture" to be on the attending staff of Mt. Sinai Hospital and pursue an academic career. He and Carol will be living in northern Westchester County. . . . Paula and **Peter Welling** have bought a house in Melrose and are expecting their first child. . . . George and **Phyllis Lantos** have just returned to New York from Boston and have "a wonderful addition to our family, a beautiful baby boy—Joshua." . . . **Keith Forsythe** is working at Lincoln Lab. . . . **Dominic Ho** is at Harvard Medical School. . . . **Roger Putnam** is a grad student in Course VI working on lasers. . . . **Larry Lasky** is doing a fellowship in blood banking after finishing a clinical pathology residency at the University of Minnesota, where his wife, Susie Fuhrman, '75, is in her third year of residency in pathology.

There are three Course VI doctoral graduates (that I know of) to report this year: **Clement Leung**, **Victor Tom** and **Don Levinstone**. Victor will be working at TASC in Reading, and Don will be at Polaroid in Cambridge after he takes an around-the-world jaunt focusing on Japan and Hong Kong. . . . Also one doctorate in Course VIII, **Kambiz Alavi**. . . . **Paul Deutsch** writes, "After graduating with an urban studies degree, I went to Harvard's Graduate School of Design for a master's in city planning. In 1974, I moved to San Francisco and still live in the Bay area, work for the Alameda County Planning Department, and travel an awful lot (Hawaii, Europe). I'm currently in charge of devising a master plan for reclamation of a six-square-mile area to be quarried until 2040, supplying 75 percent of the construction aggregate for the region, a fascinating task. (What possesses me to write after all these years?)" Other long-lost classmates are encouraged to note how easy it is to write—please! . . . **Roy Schweiker** reports in triumph, "On December 31, I climbed my last of the 181 3,000-foot mountains of New Hampshire. I am about the seventh to do this, compared to over 90 who have climbed Everest. On to Vermont." . . . **Duncan Allen** writes, "Jo-Anne and I are now living in Alexandria, Va. Our son Stewart was five in May. After two years in Calgary, working on the design of their rapid transit, which opens in May using off-the-shelf railcars identical to San Diego and Edmunton, I am working as a senior systems engineer on computerized train control for the Northeast corridor and some East Coast rapid transit projects. I do miss cross-country skiing, for which an expedition to western Maryland or West Virginia is required. Out West I could ski from the back door."

Steven McKay has been an actuary at the Social Security Administration since graduation. In 1976 he became a fellow of the Society of Actuaries. On May 30 he married Mary Sabine (University of Vermont, '71). . . . **Allan Kirkpatrick** reports that he finished his Ph.D. in Course II in September 1980 and was appointed assistant professor of mechanical engineering at Colorado State. He and Sue had a baby girl, Anne Thomson, a year ago in July. . . . **Cyril W. Draffin** writes that he is still with the U.S. Department of Energy in Washington, D.C., and has been promoted to director of industrial marketing in the Office of Solar Applications for Industry. As president of the M.I.T. Club of Washington (I'm told it's the third most active M.I.T. alumni club in the country, after Boston and New York City), Cyril has sponsored an M.I.T. reception at the embassy of the People's Republic of China, a Capitol Hill reception for M.I.T.'s President Paul Gray, and a symposium on "How to Start and Run a New Business Venture." . . . **Janet S. Lantner** is leaving Southern California Edison and the world of private industry to serve as an assistant professor of mechanical engineering at Loyola Marymount University in Los Angeles, Calif. The appointment is effective for the academic year beginning September 1981.

Richard J. Iredale, also known as Cretin, sent a newsy letter reporting that after dropping out of M.I.T. he did various things including getting involved in yacht racing and crewing for Roy Disney on the yacht *Shamrock* in Marina del Rey. He purchased a 27-foot sailboat, which he lives on at present. It's small, but has all the necessities of life—stereo, color TV, and so forth. In 1976 he returned to the lovely and scenic shores of the Charles for his last year. He graduated in 1977 with a bachelor's in bioelectrical engineering. Back on the boat he decided on business, so now he is in a two-year M.B.A. program at the University of Southern California. Last summer he applied for several patents, and he also got his pilot's license. Cretin reports that **Mike Strain** is married! And he still lives in Hamilton, Mont. The last he heard, **George Pavel** had been sharing an apartment with Duane Lindner, '73, in Berkeley and working at Lawrence Livermore, but for a year now Cretin has lost track of him. "Duane got married, too. Must be some kind of virus. Hope I don't catch it. . ."

I hope to hear from more of you soon. In the meantime I am trying to decide how to beat the heat of the city in the summer, but so far I have only succeeded in getting away on weekend trips.—Co-secretaries: **Wendy Elaine Erb**, 531 Main St. Apt. 714, New York, NY 10044; **Dick Fletcher**, 135 West St., Braintree, MA 02184

73

Hello from the heat and baseballessness of the South! Several writers grace our column this month, including **Anne McHugh**, who wrote a newsy letter of her recent move from Philadelphia to Phoenix for Honeywell's Process Management Systems Division. Anne felt a bit like another Sunbelt statistic for a while, but, as she says, "I'm settling in." She has bought a house and learned about the Arizona version of landscaping—cactus and gravel. . . . **Mike Knauer** says hello to all early '70s Fijis. They, I am sure, say hi to him, too. He is in his eighth year with Digital Equipment Corp. at the Burlington, Vt., CPU plant. Kathy and Mike have three youngsters—Katie, Tommy, and Carrie.

Steve Warsof, saying his hi to old AEPi'ers, was married to Valerie Friedman in October 1980 at the M.I.T. Chapel. They will be moving to London soon, where he will be taking a position at the University of London. . . . **Tom Fenstermacher** expects to get his Ph.D. in nuclear engineering this year (finally, he says). Tom didn't ask me to say hi to East Campusites for him, so I'll put those words in his mouth. It's a good month for hellos.

Dennis Intravia, an old friend who truly would like to say hi to Theta Chi's young and old, is employed at General Instrument of New York in their speech synthesis recognition program. . . . **David Ashley** has been named an associate professor in the civil engineering department. Dave, a Sigma Chi who would have said you-know-what to you-know-whom, has been doing research in applying systems methodology to construction problems. Congratulations to our classmate.

Tony Scandora? It's enough to get him to say hi to me! Tony and Kathy have just returned from a boondoggle in Florida. He always knew the best time of the year for the wrong weather. After all, he did go to M.I.T. And finally, yours perspiringly, who really does greet the Phi Delts he has brothered with for these many years, asks them to write regardless of class year. He also asks the correspondence of all '73s. Hope you enjoy the column.—**Robert M. O. Sutton, Sr.**, Secretary, 819 Buckingham Ct., Warrenton, VA 22186

74

For anyone out there who wants to replace or acquire a class ring, the people who made our rings originally, the Dieges and Clust Co. of Providence, R.I., have a supply of original M.I.T. Class of 1974 rings for sale. For further info call them at (401)

331-1240 and ask for Customer Service.

While working in my garden recently I had the following thoughts. The most beautiful part of any plant always seems to be the flower, the part that makes the seeds. The edible part of most fruits and vegetables is again the part that carries the seeds. What can we therefore conclude about what Mother Nature thinks about reproduction? This seems especially relevant in the light of the fact that this seems to be the time in our lives for making babies. The "baby" reported in here awhile back born to Mary and **Joe Walkush** is a boy, born Christmas day and named Joseph Francis after Joe's father. . . . Cynthia and **Ken Skier** finally tied the knot after living together for seven years. They seemed really proud of themselves for having done it. Ken's one of those creative programmer types for Wang Laboratories in Lowell, Mass. . . . Diane and **Ron Kuppersmith** have a second daughter, Meia. . . . **Hillary Morganstern** is doing clinic work now, associated with her ophthalmology studies at the Mass. College of Optometry. . . . **Dave Withee** is alive and well and living in Iowa but, considering Iowa, how can you tell? He's working with Junior Achievement, scouting possibilities for his own business beginning in the spring of 1982, is still running, and firmly resolves to train properly from now on, starting tomorrow. . . . **Charles Calhoun** and wife Terry have moved from Philadelphia to New York so that he can assume the position of senior operations analyst with International Paper Co.

In not the last birth announcement of the month (what did I tell you?), Robin and **Steve Weinstein** welcomed Kevin Louis into the world on December 9. Steve's a senior industrial engineer at Mohasco Corp. in Amsterdam, N.Y. . . . A nice note from **Glenn Nelson** crossed the desk here. He's working for Woodward-Clyde Consultants in San Francisco as a seismologist. Since 1974 he's moved around quite a bit, first working in the Santa Cruz Mountains, then to Brown for his M.S. in geophysics in 1977, working for Chevron in Houston, the U.S. Geological Survey in Menlo Park, and now San Francisco. He also mentions classmate **Judy Chalstrom**, saying she is working for Singer-Link in Santa Clara. . . . **Peter** and **Brenda Chinn Kurnik** are both beginning fellowships at Barnes Hospital in St. Louis. Peter is training in cardiology, Brenda in renal. Their brand new daughter, Rebecca, was born March 4. . . . News of **Allan Lakin** from a note penned by wife Sandra: Allan's in his third year at Loyola Law School and is also working full time as a materials scientist for Rockwell International. Home is Northridge, Calif., and as Sandra puts it, they even have a "joint project" going: "We're expecting a member of the Class of 2003 to arrive in September." . . . **Glenn Iba** married Gail Mishara in June of 1979, picked up his M.S. at M.I.T. the same year, and is still pursuing that elusive Ph.D. He plans to start teaching computer science at Hampshire College in Amherst this fall. . . . And finally, a great note from **Alan Jones** which I quote to you in its entirety: "I have a wife, two cats, design computers, and like punk rock."

Did anyone hear the joke about the scientist who couldn't spell fecundity? Well, another time. . . . Send more news.—Co-secretaries: **Lionel Goulet**, 34 Tremlett Square, Dorchester, MA 02124 and **Jim Gokale**, 12 Pond Lane, No. 54, Arlington, MA 02174

76

We are fortunate in having a lot of news this issue. **Pete Garcia** writes: "Currently a project manager with the U.S. Nuclear Regulatory Commission. My work involves the licensing of uranium mills (first stop in the fuel cycle). Married Lorna Gaumnitz June 27 in Kingsley, Iowa. **Jeff Held** was in my wedding party." . . . From **Fred Walter**: "By the end of the summer I shall no longer be a student, and shall leave Berkeley for Boulder (got to get out before the earthquake!)" . . . **Ingrid Gorman** (nee **Klass**) sends the following: "James Gorman, '75, and I were married in July 1979. I managed to get my master's degree in mechanical engineering at M.I.T. while working at Draper Labs in January 1979. I'm still working at Draper where I often see **Chris Tracey**, who also works on the Trident program, but for Dynamics Research Corp. in Wilmington, Mass. **Pat Schettig** now works for the U.S. Department of Fish and Wildlife in West Virgina. It seems she's become an avid outdoorswoman." . . . And from **Bob Quirk**: "In July 1980 I was transferred to the *Atlanta* (SSN712) being built in Newport News, Va. The weather is certainly better, and Virginia Beach has any beach in New England beat. Presently, I am the MPA (main propulsion assistant), spending a great deal of time watching and monitoring the shipyard and conducting the testing of the nuclear propulsion plant."

And now, the reunion news. The reunion started with registration and coffee at East Campus on Friday, and for late arrivals, such as your secretary, at 20 Chimneys. Attending were: **Sheri Abrams**, **Timothy Allen** and **Susan Haenar**, **Martin Brock**, **Mary Campbell**, **Eugene** and **Janice Chang**, **Peter Chang**, **Jeslie Chermak**, **Martin Deneroff**, **Allan Dubin**, **Steve** and **Laure Edelson**, **Jeff Galoway**, **Geoffrey Garner**, **Lee** and **Joanne Gearhart**, **Barry Goldman**, **Jeffrey Halis**, **Thomas Hirasuna** and **Jean Hunter**, **Cynthia Kieras** and **Michael Phillips**, **Stan Knutson**, **Reynold Lewke**, **David Littleboy**, **Peter Kaufman**, **Al Swide**, **David Maass**, **Neal Macklin**, **Greg Malkin** and **Karen Tucker**, **Tom Martin** and **Barbara Catalano**, **David Meiron**, **Jim** and **Barbara** (nee **Slocum**) **Miller**, **Janis Bestul Ossman**, **Ron Pisaturo**, **Chris Roberts**, **Gail Rubin**, **Debbie Schacter** and **Irwin Kleinman**, **Debbie** and **Jim Sharper**, **Harvey Simkovits**, **Ricky Farber**, **J. Elliot Smith**, **Duke Spear**, **Christine Tracey**, **Bill Vagt**, **David** and **Holly Walker**, **Vivian Ho** and **Holly Wu**, **Steve** and **Margaret Spura**, **Dan** and **Debbi Dershowitz**, **Diana Dickinson**, **Gary** and **Michelle Buchwald**, and **David Gabbi**. This list is not inclusive—your secretary's memory is a trifle leaky.

Saturday started out with a surprise destination—Endicott House, in Dedham, for a pick-nick. The weather held up, and the facilities, including lunch, were superb. The gardens at Endicott House, as well as the mansion itself, were a beautiful, relaxing setting for all of us. The afternoon was spent in conversations, including one with **Alan Swide**, who arrived late, on crutches. He is successfully recuperating from a motorcycle accident. Al is a summer intern at the New York Coffee, Sugar, and Cocoa Exchange, and a grad student at the Business School at Columbia University.

Some of us, such as **Geoff Garner** and your secretary, marveled at the fresh air (vs. N.Y.C.). We and perhaps ten other classmates walked among the gardens and talked. Among the topics—how lucky many of us are to be able to have our own homes, now that most Americans cannot. Being at Endicott House made some of us appreciate, thanks to the 'Tute and our own native wits, how fortunate we are.

Classmates, I am afraid more reunion details must wait. The dollar is rising like Lazarus from the grave, and the bond market is crashing. Both events (and a freeze in Brazil) are making the writing of the Notes a bit difficult. Please accept my apologies and stay tuned for Part II.—**Arthur J. Carp**, Secretary, Sandro Rohstoff, Inc., 1 World Trade Center, Suite 9853, N.Y., NY 10048

78

Good evening sports fans. As usual, this month's news comes in no order in particular. So, for no reason at all, let's start with **Sandi Haber** (now Sandi Haber Sweeney). Last year Sandi graduated from the University of Pennsylvania business school (Wharton) and, as I reported by way of unsubstantiated rumor, got married to a fellow Whartonite. Since then she has moved to the suburbs of New York City—from there both she and her husband commute into the Big Apple. Sandi's a security analyst with the investment firm of Sanford C. Bernstein and Co. She travels around the country to advise institutional investors. Her husband is a financial analyst at a New York City consulting firm.

Mark Dershowitz recently wrote to me from Houston, where he's working for Shell as a research engineer in a process economics and technology evaluation group on a wide variety of projects. In January, Mark will be marrying Hindie Becker, a teacher, originally from Connecticut. Among his hobbies, Mark's biggest is dabbling in the real estate market. He has now bought his third house and he's obtaining his salesman's license. Busy, busy, busy.

Jonos Pasztor writes that he is working as a consultant to the Church and Society Department of the World Council of Churches in Geneva, Switzerland. Specifically, he is the programme director for the Energy for My Neighbor Programme, researching the social, political, and ethical aspects of the global energy crisis. A book containing his reports will be published shortly.

Bill Kuttner was one of the first two graduates to receive an S.M. degree in transportation from M.I.T.'s Center for Transportation Studies. He's now working as an investment analyst at Pioneer Management. . . .Also in transportation is **Heather Hazard**. Heather was an editor of the recently published *Canadian Transit Handbook*; more recently, she has moved back to Boston. She's working for Cambridge Systematics, Inc., doing transportation planning and is living down in Dorchester.

Alice Cowan just sent me some gossip—**Phil Kesten** is coaching crew at the University of Michigan while working on a physics Ph.D. (Last I saw him he was also considering a law degree—mistake, Phil.). . . **Mary Zawadski** is a grad student at the University of Wisconsin and is rowing for the Mendota Boat Club. Phil, Mary, and Alice all ran into each other at the Midwestern Sprints (Alice was rowing for the Minneapolis Rowing Club). Alice also reports that **Sue Frank** got married this summer and will soon be starting law school at Boston University.

Alan Nelson writes, "I'm a Ph.D. candidate in philosophy at Chicago Circle and am beginning the Ph.D. program in economics at the University of Wisconsin. My wife Linda (famous for her Pritchett frappes) is expecting a child in November." (Two Ph.D.s???). . . **Cameron Moss** returned from Germany in July of 1980 and is now a senior test engineer with Robert Bosch Corp. of Broadview, Ill. He's living right next to the University of Chicago campus in Hyde Park.

Schlumberger seems to have enough of our classmates at one office that maybe we should have our reunion in Texas. **Jared Gould** writes that he's there with **John Marcou**, **Todd Buikema** (former roommates at SAE) and **Paul Haines**, all at the Houston office. **Rich Fagin** and **Ted Poe** recently left the Corpus Christi office, Rich to go back to Houston to work for competitor Conoco, and Ted (rumor has it) to return to Boston and marry a Simmons alumna.

From **Lorne Greenfield**: "After graduating from the Institute, spent some time in California picking up a master's at Stanford and building a jail in the desert near the Mexican Border. Have been in Chicago the past two years building a major regional shopping center. Will be married in September to Vicki Weil, Wellesley, '76." . . .**Juan Pineda** will be returning to the Tute for more punishment next year, this time for grad school in electrical engineering.

Our class vice president, **Dianna Christman Haynie**, has left the chilly Northeast and moved to the mountains of Denver. She's now working for Mobil's Mining and Coal Division and, with her husband Carl, is settling into their new house. . . . By contrast, another active member of our class, **Milt Roye**, has moved back to hometown Boston. Milt started at Harvard Business School on a GM fellowship; he'll also be serving on the M.I.T. Alumni Fund Board for a three-year term.

Jill Kern has left Babcock and Wilcox and is moving to Chicago, where she'll be starting the M.B.A. program at the University of Chicago. Her husband, Jeff Grossman, '76, will be returning from a long stint in Korea with Uncle Sam's Signal Corps, and joining her in Chicago. Doctor **Boris Ackerman** just graduated from Dartmouth Medical School, and will be interning in surgery at the University of California at San Diego.

Bob Drescher, who received both a bachelor's and master's in mechanical engineering in 1978,

won an Alexander Proudfoot Co. fellowship for his excellent performance at the Sloan School. The fellowship was established to develop an awareness of productivity as a major concern for American industry. . . . I ran into **Mike "Indiana" Geselowitz** on the Harvard bridge the other day. Mike is preparing for his qualifiers for his Ph.D. in archeology at Harvard. When I saw him, he was in a bit of a rush, but he mentioned an important project concerning a golden ark. I'll keep you informed if he finds anything.

And then there's me. I'm writing in the middle of July and will be taking my bar exam in five days. Wish me good luck . . . retroactively. As of now, I'm living in Cambridge and still looking for work as a attorney in the Boston area. Next issue, hopefully, I'll tell you all about my new job. In the meantime, it's back to studying torts and procedure.—**David S. Browne**, Secretary-Treasurer, 106 Otis St., Cambridge, MA 02141, (617) 491-2368

79

Greetings, classmates! First, let me apologize for missing last month's column. Between graduating, finishing my thesis, moving from Philadelphia, taking the obligatory post-graduation trip to Europe, finding an apartment in New York City, and starting a new job, I'm afraid *Technology Review* got squeezed to the bottom of the priority list. I'll try not to let you down again. In the meantime, lots of news.

Dan Nathan heeded my call at the end of my last column and dropped me a line. (Other freshman-year friends, I'm still waiting to hear from you!) After graduating M.I.T., Dan spent 10 months as a self-confessed bum working his way across Europe. He's now in his second year at NYU Law School, "enjoying it as much as one reasonably could." Unlike most of his fellow classmates, Dan claims that law school has turned him into a "bona fide liberal." He says, "I'm a member of the editorial collective of the law school newspaper, a radical rag, and I hope to spend the summer fighting landlords to give tenants the illusion that they have some legal rights in a Reagan-oriented world!" When he's not studying or championing his cause, Dan is doing a lot of guitar playing and singing, and was even a happy hoofer in the law school show, the "Law Revue", but he confesses that he misses the Logarhythms! Thanks for writing, Dan. . . . **Susan Ann Silverstein** finished her first year at Columbia Law School and also found it to be a radicalizing experience! She is doing all sorts of political work, both in and out of school, and plans to go into some field of public interest law that is ralated to science policy (occupational health or energy issues). "Despite my infinite school work and overcommitted extracurricular activities, I continue to write poetry and prose, and I even manage to juggle a somewhat rampant social life!"

Congratulations are in order for several class members on several auspicious occasions. . . . **Esther Jaffe** and husband Jeff, '76 (Ph.D. '79), welcomed little Jacob into the world on December 4, 1980! During her six-month maternity leave from Philips Labs, Esther started classes at Columbia towards a master's in electrical engineering and at press time she planned to go back to work part time at the end of her leave. She reports that being a mother is a full-time job—"Believe it or not, it's harder than problem sets, but a *lot* more rewarding. I just love it!" . . . **Marla Eglowstein** was on Cloud 9 when she called to tell me that she would be starting medical school in August. She's at St. George's University on the island of Grenada in the British West Indies. She was trying to prepare herself to "live with the revolutions, the bugs, the hurricanes—and the other medical students!" Marla spent two years living in Newton and working as a research technician at Children's Hospital. . . . **Jay Ericson** (a.k.a. William B. Ericson, Jr.) and Barbara Smith, '77, were married on April 11 in—of all places—the M.I.T. Chapel! Also present were **Gilbert Godbold** and **Roger Silverstein**, as well as Jay's dad, William Ericson, '51. The reception was held at the Institute of Contemporary Art. Jay is at the Harvard Medical School and Barb is in an M.D.-Ph.D. program in the Harvard-M.I.T. Division of Health Sciences and Technology. Both hope to graduate in 1983. . . . **Crawford Smith** just finished his master's in aeronautics and astronautics from Purdue University, where the undergraduates in his department voted him one of the two outstanding teaching assistants! After his wife Martha got her master's in agricultural economics in August, the Smiths returned to the Boston area, where Crawford began work with General Electric in Lynn. . . . Your faithful secretary was present at the lovely May wedding of **Jan Nielsen Rickey** and David Rickey. Jan and David met at Stanford, where they both received master's degrees in materials science and engineering last spring, and both just started new jobs with IBM in Burlington, Vt. Jan's bridesmaids were **Claire (Ventimiglia) Pelaez**, Carol Pokodner, '78, and Karen Seo, '75. Claire got her master's degree in nutrition and food science from the 'Tute in December 1979, married Joaquin Pelaez, M.S. '79, in January 1980, and is now working on ice cream cones and new products for Maryland Cup. Other M.I.T.ers present were Scott Prey, '78, and my good friend Barbara Ostrov, '78.

Out in the Golden State, the following class members have turned up: **Charles Jackson** is "settling in for another few years out in sunny California. My research topic is non-destructive evaluation of metals with ultrasound, with the Ph.D. two terms of classes and a few years of lab work away." . . . **Gerry Swinton** has been sailing Ultra Light Displacement Boats, Moore 24s, and 22-knot 50s in Santa Cruz. He says "hi" to Debbie M. . . . Meanwhile, **Debra Meyerson** got her M.S. from Sloan in 1980 and is now living in Tahoe City, Calif. "I've been acting as managing director of Women's Way Adventures, Inc., a nationwide company which runs and markets ski instruction and fitness programs across the country as well as product consulting and endorsing various sports lines. I've also been a part-time member of the Squaw Valley Ski School." . . . **Elaine Sears** got her master's in mechanical engineering from Stanford last January, where she studied automatic control systems. She's now working for Systems Control, Inc. in Palo Alto. Elaine reports that she sees **Marcia Grabow** often. Marcia is at Stanford working towards her Ph.D. in materials science. . . . Meanwhile, back in Massachusettes, **Elliot Rossen** says he has been "talking frequently to **Debbie Meyerson** and **Marcia Grabow** in California, and learning the great advantage of the East Coast!" Elliot spent almost two years with the management and economics consulting firm of Temple, Barker, and Sloane in Lexington. After spending May and June in Europe, he started at the Harvard Business School in the fall. . . . Also heading to HBS this fall is **Steven Simonoff**, who was most recently manager of software development at Digilab in Cambridge.

I've made some transitions recently myself. I did manage to chalk up an M.B.A. from Wharton and an M.S.E. in computer science from the University of Pennsylvania before splitting Philadelphia in June. Since July I've been in the Finance Department at Mobil Corp. in New York City. I'm in a rotational program which allows me to spend six months in each of four different areas of the fianance department—tax, treasurer's, controller's, and systems. I have also joined the ranks of Manhattanites so please note yet another change of address.—**Sharon Lowenheim**, Secretary, 131 E. 83 Street, Apt 2G, New York, NY 10028

80

It seems like ages since I sat down to write a class notes column. Maybe it's just an illusion of summer. I am writing this in the midst of the season that always makes me sit back and quesiton why I decided to stay in Boston.

One good thing that summer always brings in, however, is weddings. On May 24, **Tony Parham** married Catherine Worsley, '82, followed by a reception in Baker House. Tony returned to the University of Southern California the next week to receive his master's degree in computer science, before coming back to Boston to settle in Somerville. Tony is now working for Hewlett Packard in Waltham. Among the wedding guests were best man **Clifton McFarland**, **Ron Efromson**, and **Jamie Burnside**. A recent trip to Nova Scotia earned Jamie the first place prize in a pig race. Ah, what we can do with an M.I.T. degree.

Errol Antzis married high school sweetheart Janet Harper in May. ("When I first arrived at M.I.T., they told me it couldn't be done!") After spending a two-week honeymoon in the Caribbean, Errol and Janet set up house in Manhattan. Errol is now an M.B.A. student in finance at New York University. . . . **Lynda Halverson Selan** has been working for the Architecture/Engineering/Construction Services division of M.I.T.'s Physical Plant for the past year. She has now given this up to become a full-time mother and wife for a while. Lynda and Greg had a 10-pound, 6-ounce, 21-inch son on April 30, named Nicholas Halverson Selan. The family has now moved to West Virginia, Lynda's home state. . . . **Marlon Weiss** writes that he has been working as an engineer in the materials and processes department of Boeing Military Airplane Co. in Wichita, Kans. "Work is not quite what I expected. I sit around all day waiting for problems or questions concerning thermoplastics, sealants, and carbon-fiber composites. Sometimes I just go out to the plant and watch them build planes. In spite of the boredom, I have gotten quite a lot of experience." Marlon is now starting medical school at the University of Nebraska, fully equiped with a Regent's Scholarship to help him on his way.

A June *Tech Talk* article reports that **Lorraine Olson** has been named an Ida M. Green fellow for the upcoming school year. Lorraine is an S.M. candidate in mechanical engineering at M.I.T. Congratulations, Lorraine! . . . Digital Equipment Corp. in Maynard, Mass., seems to have attracted a number of our classmates. Among these are **Jim Jackson**, **Gary Engelson**, **Denise Cline**, and **Bruce Leshay**. Jim and Gary are both living in Acton, and Gary says that he is really enjoying living in the country. . . . Also working for DEC is **Darrell Hartwick**. Darrell has been working as a manufacturing engineer, helping to smooth the transition between the designers of a new product and those who eventually manufacture it. Unfortunately, his job is in the process of being phased out! When I heard from Darrell, he gave no clue as to what his new assignment would be . . . **Rich Tucker** joined MITRE in McLean, Vir., in March of this year. Rich is playing in tiddlywinks tournaments and working on a test bed automated en-route air traffic control system now and then. . . . **Jim Franklin** reports that he is continuing to do the weather for *The Tech*. Somehow, there must be something more to life than that, Jim.

Just prior to commencement every June, the M.I.T. Corporation meets to, among other things, elect new Corporation members. In addition, members of the three most recent classes ('79, '80, and '81) have the opportunity to elect one member from their ranks to the Corporation. Elected this year, for a five-year term, was **Barbara Johnston**. Later that day, Barbara received an S.M. degree in civil engineering. Barbara is now a field engineer with the George Hyman Construction Co. of Bethesda, Md. Congratulations, Barbara!

I guess it's time to start an erratum section to my column. A few months ago, I incorrectly stated the activities of **Tim McManus**. Tim's activities this past year have actually been work with Honeywell's Defense Systems Division in Minneapolis. As of the 1981-82 school year, Tim is returning to the 'Tute and will be attached to the Sloan School.

Well, I've had my say for the month. Try to keep me busy, folks; I enjoy the challenge. I just dare you to try to fill my mailbox.—**Ken Turkewitz**, Secretary, 3 Winslow Rd., Belmont, MA 02178

81

I hope no news is good news since I've received no letters to date. Please write and share your exploits.—**Chuck Markham**, Secretary, 532 Beacon St., Boston, MA 02215, (617) 262-3192

Courses





Some 70 colleagues, friends, and former students of Professor-Emeritus Jacob P. Den Hartog (right) gathered to celebrate his 80th birthday at Boston's St. Botolph Club last July. Dr. Den Hartog, former head of the Department of Mechanical Engineering, has a world wide reputation as "dean of vibration engineers." The occasion also marked the inauguration of the J.P. Den Hartog Distinguished Educator Award which was presented by Professor Herbert H. Richardson, '53 (left), present head of the department, to Professor James H. Williams, '67. The award, endowed by the Mechanical Engineering Department graduate alumni, will annually honor a faculty member who, like Professor Den Hartog, "has served as an inspiration for students and has fostered the development of physical insight and engineering judgment." (Photos: Perry Photography)

I
Civil Engineering

Five members of the M.I.T. community were honored this summer for their pioneering success with the Smith-Putnam Wind Turbine, a 1,250-kilowatt wind-powered generator placed in operation on Grandpa's Knob near Rutland, Vt., on August 29, 1941. As the world's first megawatt-sized wind turbine, the machine produced power for the grid of the Central Vermont Public Service Corp. for a total of about 1,100 hours between October, 1941, and March, 1945, when operation terminated upon failure of a blade.

Cited by NASA and the Department of Energy "for their foresight, leadership, and contributions to the development of wind power as a renewable source of energy" were:

☐ **Palmer C. Putnam,** '23, originator and leader of the turbine project.

☐ **Beauchamp E. Smith,** a former member of the M.I.T. Corporation who is now vice-president of Allis Chalmers Manufacturing Co. The S. Morgan Smith Co., of which Mr. Smith was then vice-president and general manager, was a principal sponsor of the experiments by Mr. Putnam that led to the Smith-Putnam machine.

☐ **John B. Wilbur,** '26, professor emeritus of civil engineering at M.I.T. who was chief engineer of the Smith-Putnam turbine.

☐ **Myle J. Holley, Jr.,** '39, professor emeritus of civil engineering at M.I.T. who worked in structural engineering on the Smith-Putnam team while an M.I.T. graduate student.

☐ **Hurd C. Willett,** professor emeritus of meteorology at M.I.T., who was site selection manager for the Smith-Putnam project.

Presentations to the Smith-Putnam team were a feature of a workshop on large horizontal-axis wind turbines sponsored by NASA and DOE in Cleveland last July.

Ronald E. Nece, Sc.D.'58, reports that he is currently chairman (1980-81) of the Executive Committee, Hydraulics Division, of the American Society of Civil Engineers and is preparing to assume his duties as president-elect of the Seattle section. . . . **George P. Turci,** S.M.'56, president of American Bakeries Co., Chicago, Ill., has been elected chairman of its Executive Committee. . . . **Jozef Keselman,** S.M.'76, writes, "After six wonderful months in Tokyo modernizing one of Exxon's refineries, I transferred to Normandy, France, to work on another refinery modernization project for Esso Societe Anonyme Francaise and am striving to learn French." . . . **Joseph J. Rixner,** S.M.'68, has been appointed manager of H & A of New York, Rochester, a subsidiary of Haley and Aldrich, Inc., Cambridge, consulting firm for geotechnical engineers and geologists. **Jerome B. York,** S.M.'61, has been appointed assistant controller of manufacturing and purchasing for Chrysler Corp., Detroit, responsible for financial control and investment analysis.

Word has been received of the death in 1979 of **Howard J. McCrodden,** S.M.'39, formerly a member of the Department of Civil Engineering at Montana State University, Bozeman. . . . **Herbert L. Alley,** '29, of Tavernier, Fla., passed away on December 31, 1980.

II
Mechanical Engineering

Thomas Zebehazy, S.M.'72, writes, "I have recently become a design engineer in the van chassis design group at the Chevrolet Engineering Center." . . . **Masao Ohi,** S.M.'75, is currently working for Hitachi Ltd., and reports that his responsibilities include design, estimates, and development of turbine generators, especially the gas turbines. "Since I studied AC machine analysis as a graduate student at M.I.T., I have been greatly supported in my job." . . . **Leon F. Punsalan,** S.M.'41, is presently assistant professor emeritus (as of 1977), at the University of Maryland, Eastern Shore, and an entrepreneur of Punsalan Home Rentals, Virginia Beach, Va. . . . **Arthur E. Bergles,** S.M.'57, chairman of mechanical engineering at Iowa State University, is one of five authors of *Two-Phase Flow and Heat Transfer in the Power and Process Industries*, published by Hemisphere Publishing Corp. and McGraw Hill, July 1981. The book presents both basic and applied knowledge with focus on

Beinart Interim Head as Habraken Steps Down

During six years as head of the Department of Architecture (since 1975), Professor Nicholas J. Habraken has "created a new framework for architecture education" by making research "an integral part of design education," says Professor William L. Porter, Ph.D.'69, former dean of the School of Architecture and Planning. Now Professor Habraken has asked to be relieved of administrative duties, and Professor Julian Beinart, M.Arch.'56, will serve as interim head while a search is conducted for a permanent successor.

A native of South Africa, Professor Beinart first came to M.I.T. in 1954 as a graduate student. Then followed advanced study in city planning at Yale, an active practice in architecture and planning in South Africa, and teaching at the University of Cape Town, where he was head of the department and dean of the Faculty of Fine Art and Architecture. Professor Beinart joined the M.I.T. faculty in 1969; since then he's had a major role in a national study of architecture education funded by the Andrew W. Mellon Foundation and last year was elected president of the International Design Conference in Aspen, Colo.

the thermal benefits, safety procedures, design systems, and instrumentation for such systems.

Amad Taybei, Sc.D.'73, former associate professor of plastics engineering at the University of Lowell, Mass., has been promoted to the rank of full professor. . . . **Richard Hedderick,** S.M.'67, has been named manager of applications development and technical services for the Polymer Chemicals Division of Air Products and Chemicals, Inc., Allentown, Penn. . . . **George S. Reichenbach,** Sc.D.'52, has been named a vice-president for the Bonded Abrasives Group at the Norton Co., Worcester, Mass. The Alumni Association has been notified of the death in 1978 of **A. Robin Mowlem,** 46, of Poughkeepsie, N.Y.

III
Materials Science and Engineering

William Griffith, S.M.'50, reports that he received the Robert H. Richards Award at the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME) annual meeting in Chicago, February 1981. . . . **Edward T. Stephenson,** S.M.'56, a senior scientist in the Research Department at Bethlehem Steel Corp., has recently co-edited a technical book, *Energy-Efficient Electrical Steels,* published by the Metallurgical Society of AIME. The book is a 219-page, illustrated hardcover, incorporating 12 technical presentations in which the energy efficiency of a wide range of electrical steels is discussed by steel suppliers and users.

Klaus M. Zwilsky, Sc.D.'54, writes that he has been appointed executive director of the National Materials Advisory Board at the National Academy of Sciences. Previously he was chief of the Materials and Radiation Branch, Office of Fusion Energy, Department of Energy. . . . **Francois M. Grandpierre,** S.M.'58, has resigned as director of the Certain-Teed Corp., Valley Forge, Penn., a maker of building materials and glass fiber and piping products. . . . **Roger A. Covert,** Sc.D.'57, has been promoted from general sales manager for the plating industry, to manager of the plating and chemical industries at International Nickel Co., Inc., New York City.

IV
Architecture

Barnett B. Berliner, M.Arch.'52, who teaches real estate development as a member of the faculty at the Boston Architectural Center, recently led an all-day seminar on "Urban Real Estate: Financial Feasibility of Retail Specialty Centers" at Southern Illinois University, Edwardsville. In his presentation, he utilized the Harvard Business School case study method for real estate development, as applied to the Faneuil Hall Marketplace, Boston; the Crimson Galleria, Cambridge; and Boston 3-deckers.

Kenneth H. Wallijarvi, M.Arch.'51, of Edina, Minn., passed away on April 22, 1980. . . . **R. Bruce Miller,** M.Arch.'56, of Oklahoma City, Okla., passed away on July 4, 1981, as notified by his wife, Adele.

VI
Electrical Engineering and Computer Science

Professor **Sanjoy K. Mitter,** who joined the department in 1969, was chosen last summer to succeed Professor **Michael Athans** as director of the Laboratory for Information and Decision Systems—formerly the Electronic Systems Laboratory. Professor Athans will return to full-time teaching and research in systems science and engineering.

Professor Mitter first came to M.I.T. as visiting associate professor in 1969; he was appointed to the faculty a year later. His association with LIDS dates to his arrival at the Institute, when he began work at the laboratory in systems and control theory; recent research has concerned the behavior of stochastic dynamical systems.

Wilbur B. Davenport, Sc.D.'43, professor of communications science and engineering in the department at M.I.T. and **Paul E. Green, Jr.** Sc.D.'53, a member of IBM's Corporate Technical Committee, Armonk, N.Y. are among four winners of the Aerospace and Electronic Systems Society 1981 Pioneer Award, for contributions in the development of spread-spectrum communication. . . . **Ernest S. Kuh,** S.M.'50, professor of electrical engineering at the University of California, has been awarded the 1981 Education Medal by the IEEE for leadership in engineering education and contributions to research in circuits and systems.

John M. Fluke, S.M.'36, chairman of John Fluke Manufacturing Co., Portland, Ore., has been elected a director of Fred Meyer, Inc., a retailing and savings and loan concern. . . . **Edward H. Sussenguth, Jr.,** S.M.'59, has been selected as an IBM Fellow for a term of at least five years, free to pursue any research of his choice; he plans to explore advanced technology in data communications. Prior to his fellowship, he was director of architecture of the IBM Systems Communication Center, Raleigh, N.C. . . . **Robert Dirkman,** S.M.'60, former assistant professor of electrical engineering at the University of Lowell, Mass., has been promoted to the rank of associate professor. . . . **Nelson E. Bolen,** S.M.'60, has been promoted from head of the Information Distribution Systems Department at the Mitre Corp., Bedford, Mass., to associate technical director of the Tactical Command and Control Division.

Dale Reis, S.M.'70, has been named manager of the Cobra Judy Program at the Raytheon Co.'s Equipment Division, Wayland, Mass. Cobra Judy is a shipboard phased-array radar system which will be used to support missile and space research and development activities. . . . **Stephen J. Jatras,** S.M.'52, president of Telex Corp., Tulsa, Okla., has been named chief executive officer, a maker of computer and communications equipment.

Moses, Adler, and Elias Named as Heads in Course VI

The Department of Electrical Engineering and Computer Science—M.I.T.'s largest—has completed its reorganization following the departure of Professor Gerald L. Wilson, '61, former head, who is now dean of engineering.

At the helm as new head of the department is Professor Joel Moses, Ph.D.'67, widely recognized for major computer system developments, who had been associate head of the department since 1978.

Professor Richard B. Adler, '43, continues as associate head for electrical science and engineering; he is a specialist in semiconductor electronics and electromagnetic and circuit theory.

Peter Elias, '44, Edwin S. Webster Professor of Electrical Engineering, is acting associate department head for computer science and engineering. His special field is information theory and its application to computer processing.

Professor Moses came to M.I.T. in 1963 following undergraduate study at Columbia University, and he joined the faculty upon receiving his doctorate. He served as associate director of the Laboratory for Computer Science from 1974 to 1978. Professor Adler has also served on the faculty since completing graduate study, working in electronic materials and bioengineering. Professor Elias, who was head of the Department of Electrical Engineering from 1960 to 1966, holds advanced degrees from Harvard; his work on communications and information theory has been in association with the Research Laboratory of Electronics.

VII
Biology

Dr. **Alexander Rich,** Sedgwick Professor of Biology and professor of biophysics at M.I.T., has been elected to the board of directors of the Medical Foundation, Inc., Boston. The foundation is a charitable organization that supports research on a broad spectrum of diseases and engages in projects related to problems of community health. . . . **Warren H. Southworth,** DPH'44, writes, "At last it has happened. I have retired from the University of Wisconsin, after 37 years of teaching, research, and service, and am now an emeritus professor. As I think back to the years 1939-1944, the names of some very special people come to mind—C.E. Turner, Charlie Blake, Samuel Prescott, J.W.M. Bunker, John Williams, Murray Horwood, and Jenni Jennison. I wish these great people could know how much influence they have had on my personal and professional life. I am deeply greatful to them." During his retirement, Dr. Southworth plans to be a volunteer patient educator at the University of Wisconsin Hospital and also intends to spend much more time with his wife and their travel trailer.

Rita M. Kelley, MPH'42, an internationally known cancer specialist, passed away on July 22, 1981. She was a medical oncologist at the Massa-

chusetts General Hospital and clinical professor of medicine at Harvard Medical School since 1951. She held honorary doctorate degrees from Suffolk University and Boston State College and was a recipient of the Bronze Medal of the American Cancer Society. The MGH Hospital's Cox Center for Cancer Management is a tangible tribute to her skill as a care-giver: since its opening six years ago, more than $200,000 has been donated in her name. . . . **David Atwater,** '17, of Westover, Mass., passed away on June 17, 1981; no details are available.

X
Chemical Engineering

Robert C. Reid, Sc.D.'54, who has contributed as a member of the M.I.T. faculty since 1954 to research and teaching in chemical thermodynamics and the properties of gases and liquids—especially of liquefied natural gas—is now Chevron Professor of Chemical Engineering.

The professorship was given by Chevron USA, the major domestic subsidiary of the Standard Oil Co. of California, late last year, and Professor Reid is its first occupant. He assumed the new post upon returning to Cambridge after a year in Madison, Wisc., where he was Visiting Olaf A. Hougen Professor at the University of Wisconsin for 1980-81.

In addition to extensive studies of the safe handling, transportation, and storage of LNG, Professor Reid's research has included phase transition in superheated liquids, supercritical extraction processes, the migration of food wrapping materials to food, and material flows in living plants. He has held a number of visiting lectureships, has twice been chosen by chemical engineering students as the outstanding teacher in the department, and in 1976 was cited by the American Institute of Chemical Engineers for "extraordinary classroom teaching" with its Warren K. Lewis Award. Professor Reid was himself a student of Professor Lewis in 1951—an association which he says has had a strong influence on his own teaching methods.

Wayne H. Pitcher, Jr., Sc.D.'72, is currently project supervisor—biotechnology portfolio in the Research and Development Division at Corning Glass Works, Corning, N.Y. . . . **Clarence Eckmann,** S.M.'42, writes of "a wonderful trip spending three weeks at Sarasota, Fla., where we have a number of retired relatives and old friends, and getting back just before the Memorial Day holiday weekend. Otherwise enjoying a variety of retirement activities in Wisconsin along with travels around the country." . . . **Earl E. Patterson,** Sc.D.'50, is currently technical assistant to the general manager at the Reynolds Metals Co., Richmond, Va., responsible for training and technical information.

XIV
Economics

Lester C. Thurow, professor in the Sloan School of Management, has joined the staff of *Newsweek* magazine as a contributing editor and as a regular columnist on the issue of economic opinion. His column will appear every three weeks in the business section of the magazine. . . . **Vernon H. Grigg,** Ph.D.'54, who has served with the Exxon Corp. and its subsidiaries for 29 years, will join the economic faculty in the University Program at the University of South Florida, Sarasota, commencing in September 1981. . . . **Theodore M. Alfred,** Ph.D.'63, dean of the Weatherhead School of Management at Case Western Reserve University, has been elected a director of Acme-Cleveland Corp., Cleveland, Ohio, a maker of machine tools, foundry machinery, and expendable tools for metal cutting.

Stephen J. Browne, Ph.D.'72, has been named a director of international investments of the Planning Economics Group of Boston, Woburn, Mass. . . . **Alice J. Kidder,** Ph.D.'67, has been appointed associate professor of transportation at Syracuse University, N.Y. For the past year she has been a visiting professor at the university's School of Management, and prior to this she was on the faculty at North Carolina Agricultural and Technical State University, Greensboro, for 11 years.

XV
Management

John A. Fanning, S.M.'65, president and chief operating officer of Western Co. of North America, Fort Worth, Tex., has been elected to the additional post of chief executive officer. . . . **Richard S. Bodman,** S.M.'61, president and chief executive officer of Comsat General Corp., has been elected a director of Emhart Corp., Farmington, Conn. . . . **Robert I. Blakely,** Ph.D.'70, vice-president and chief financial officer of U.S. Synthetic Fuels Corp., Washington, D.C., has been named senior vice-president and chief financial officer of Tenneco, Inc., Houston, Tex. . . . **Donald H. White,** S.M.'70, has been appointed senior vice-president and controller of Hughes Aircraft Co., Los Angeles, Calif., serving as the chief accounting officer of the company.

Ram T. Kirpalani, S.M.'59, professor of business administration at Baldwin-Wallace College, Berea, Ohio, received a Fulbright Grant to study economics and industrial growth in Egypt. His six-week study tour, ending August 12, 1981 included visits to Cairo, Alexandria, Suez, Aswan, and Luxor. . . . **Clive Eustace,** S.M.'58, has been vice-president of strategic planning at Phoenix General Insurance Co., West Hartford, Conn.

Sidney B. Jeffreys, S.M.'32, writes that he is currently a registered professional engineer for Management Industrial Engineering, Greensboro, N.C. . . . **J. Scott Armstrong,** Ph.D.'68, writes, "I spent the past year as a visiting professor at IMEDE, an institute for management education, and as of September 1981, I returned to the Wharton School at the University of Pennsylvania. I am involved with three other professors—from Canada, England, and France—in starting a new journal, the *Journal on Forecasting*, to publish papers dealing with forecasting methods in the management and social sciences." . . . **Melford E. Monsees,** '58, is presently coordinator of the graduate engineering program at the University of Missouri, Kansas, and director of Richard Muther & Associates, an engineering consulting firm.

Sloan Fellows

Janet Millenson, S.M.'76, reports that she is a marketing consultant to small technical enterprises and was recently married to Herb Edelstein, vice-president of International Data Base Systems, Inc., and lives in Wynnewood, Penn. . . . **Ronald B. Peterson,** S.M.'73, has been elected vice-president for development of the Grumman Corp., Bethpage, N.Y., a holding company. . . . **Conrad Firmino Desieno,** S.M.'60, has been elected to the new post of vice-president, rate research and design, of American Electric Power Service Corp., New York City. . . . **Harold J. Fitzgeorge,** S.M.'64, was named a director and will become chairman and chief executive officer of Pennzoil Exploration & Production Co., Houston, Tex., a division of the Pennzoil Co. He also became a member of the executive committee of the parent company.

Goff Smith, S.M.'53, chairman of Amsted Industries, has been elected to the board of Beatrice Foods Co., Chicago, Ill. . . . **Paul Polishuk,** S.M.'56, president of Information Gatekeepers, Inc., will be leading a study group visiting major Japanese manufacturers, laboratories, and actual installations, observing the state-of-the-art of fiber optics currently in use in Japan. Officially billed as an International Industrial Study Mission to Japan, the 16-day tour (November 28 through December 12, 1981) has been designed for top management and technical research staff interested in the increasing high-technology of Japan's fiber optics industry. **Thomas M. Purdue,** S.M.'78, manager of a major army research effort to develop technology for a low altitude ballistic missile defense system has been selected by his employer, the Ballistic Missile Defense Organization to receive the army's Meritorious Civilian Service Medal.

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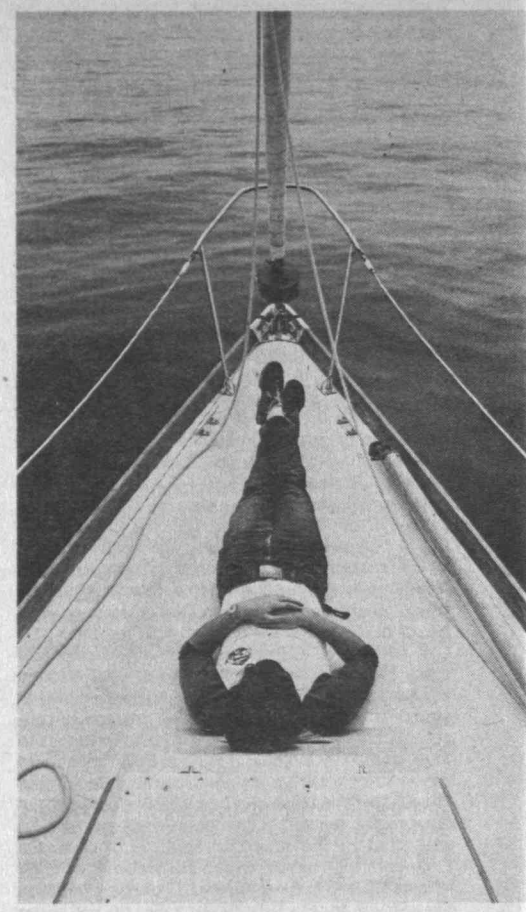
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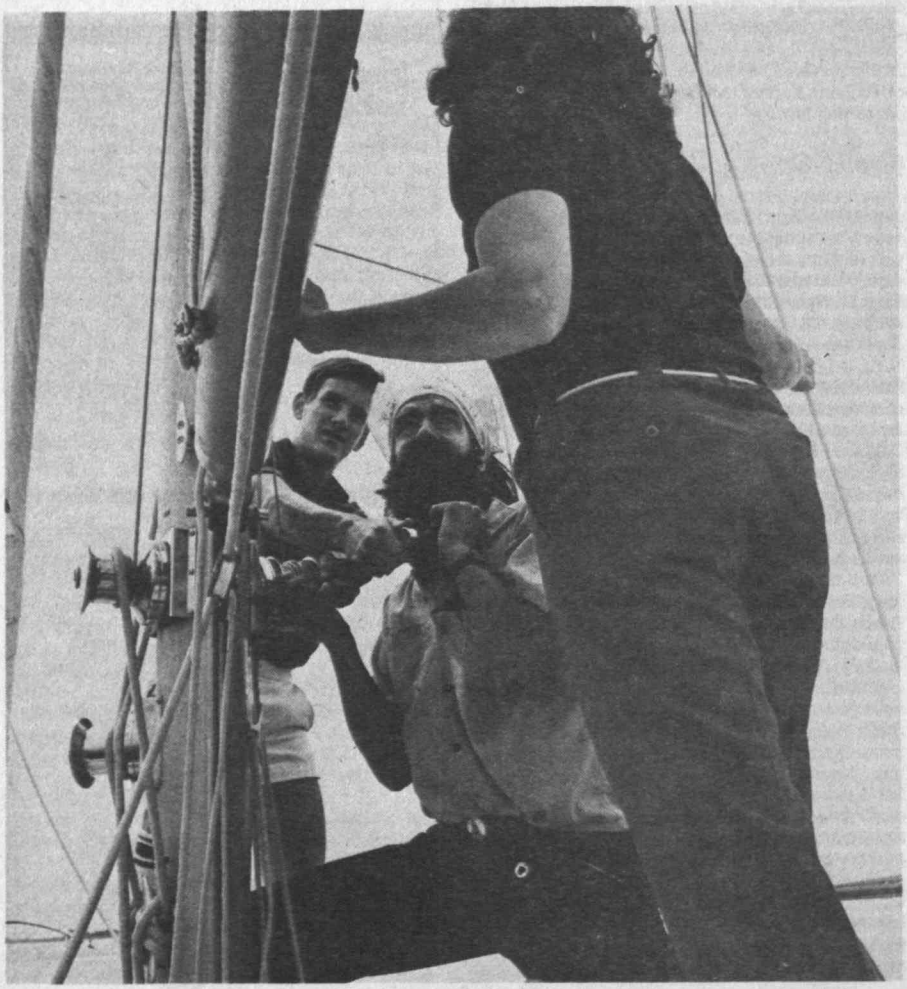
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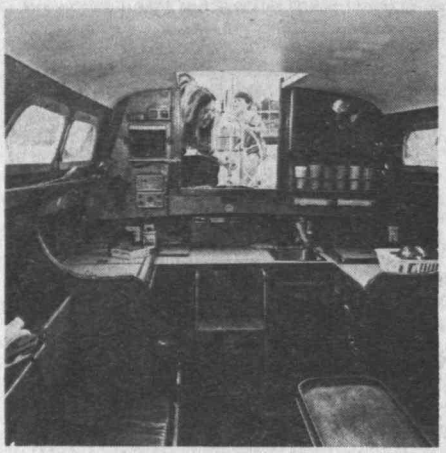
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A dream which Walter C. ("Jack") Wood, '17, never expected to see fulfilled: the experience of cruising made available to M.I.T. undergraduates. Then came Albert Hopeman, '34, to give his Hinckley 38 to the M.I.T. Cruising Club for weekend trips and a four-week summer cruise Down East. The pictures show three student families learning the pleasures of cruise-yacht sailing on Boston Harbor last August. (Photos: James J. Snyder, '81)

How Erwin Schell, George Owen and Karl Compton Helped Jack Wood Bring Sailing to M.I.T.—and Almost Everywhere Else, Too

By Aileen Kilgore Henderson



Walter Cromwell Wood, '17. Recognize that name? You should—you owe him a debt. But for "Jack" Wood you might not be sailing; and neither would thousands of other non-millionaires. For Jack Wood has done more than anyone else to bring the sport of the rich within the experience of almost everyone.

Born in New Bedford in 1894 and bred in Newport, R.I., Jack Wood has been known for decades as the "father of intercollegiate sailing" for his zeal to initiate others into the joys and challenges of the sport. He is in the number-one niche of the Intercollegiate Sailing Hall of Fame at the U.S. Naval Academy, Annapolis; the trophy awarded annually at the Pentagonal Dinghy Regatta, oldest of intercollegiate competitions with permanent participants, is named in his honor; so is the new sailing pavillion at M.I.T., where Jack was sailing master for 27 years.

All Hands Up for Sailing

When Jack looks back, he admits that no one foresaw the consequences of M.I.T.'s decision in 1936 to provide recreational sailing for its student body. It all began when some M.I.T. boys approached him in the early 1930s about finding boats to sail in a frostbite meet to be held in Providence, where Jack was then owner of a boat hardware business. This led eventually to a frostbite race in Boston, and as luck would have it Professor Erwin Schell, '12, head of M.I.T.'s business administration course, was watching out his office window.

Thinking about what a good recreation sailing would be for M.I.T., right there on the Charles, he went off to see Professor George Owen, '94, who was then head of the Department of Naval Architecture, and together they went to see "Jack" Wood.

From then on things went pretty fast, recalls Jack. He brought his dinghy up to the Institute from Providence, and Professors Owen and Schell announced in various publications that a sailing program was being organized. Here is how Jack remembers it:

"Just before our organizational meeting, which we'd set for late afternoon, Professor Schell got a group of boys to parade through the buildings banging on drums and making noise. People flocked after them, right into the meeting room, just to see what was happening. When everyone had crowded in we shut the doors. We had our captive audience. Karl Compton, M.I.T.'s president, was very eloquent in his presentation, and things went off well. At one time everybody in the room all had hands up. We got 500 prospective sailors out of the first meeting."

Later Professor Schell organized a fund drive for the boats, and Jack Wood recalls that he thought 12 dinghies would be enough. Professor Schell wanted 24, and when he called some prospective donors together everyone in the meeting ordered a boat to be given to M.I.T.—a total of 48. "They didn't argue about why or how many; they just talked about whether to have a cat rig or a sloop rig," recalls Jack.

They settled on the cat rig, for simplicity and because it would make a better teaching boat. Jack thinks it's best to start teaching with a boat with a single sail. "Your attention is on that sail and the boat and the sailing of it—not on how to manage two sails."

All this was in 1936. A year later 27 colleges were invited to compete in Boston Dinghy Club races at M.I.T., and two years later the Intercollegiate Yacht Racing Association (IYRA) had 1,300 individual members from 31 colleges; today over 100 colleges and universities belong.

Before World War II most of the teams from these colleges were for men only. But from the beginning M.I.T. had no sex discrimination, and sailing turned out to be "one of the things the girls liked to do most," Mr. Wood says. Most of the early competitions were for men only, and the co-eds were upset about being cut out, but Jack Wood urged a different view. "Rather than this being a set-back for women," he remembers, "I thought it was a grand opportunity for them to have more attention—teams of their own, races of their own—and more women sailing . . . their own meets with their own championships." And it worked out that way.

By 1940 Jack Wood was involved in community sailing, in addition to his work as M.I.T.'s sailing master. Already a Community Recreation Service in Boston had begun a sailing program, but there were lots of problems; the Metropolitan District Commission said it would take the program over—*if* Jack Wood would come in and run it. He did—and in the first year at least 400 children from all over Greater Boston came to the Charles River to learn sailing.

Through the years Jack Wood developed a whole series of gadgets for teaching sailing—a bottom-action winch whose handle doesn't have to be removed—it's in the base; a fusee-type winch for trimming sails on Stars; a "sail magazine" for changing sails very quickly; an automatic starting signal for frostbite races (now the system for starting all collegiate races, making stopwatches unnecessary); a method of storing sailboats so that the sail, boat, and spars are all together under lock and key; a way of attaching wheels to boats to get them to and from the water more easily.

When he retired from M.I.T. in 1965, Jack went to England with the intercollegiate sailing stars to help coach the exchange races with members of the British Universities Sailing Club. The next year he came to the San Diego Yacht Club to develop its junior program. He was a member of the Olympic Committee that chose U.S. sailing contenders for the Mexican Olympics in 1968. In June 1972, he worked as honarary chairman of the Intercollegiate Yacht Racing Association's national championships held in San Diego.

Now 86, he's slowing down a little, living with his wife Helen on an inconspicuous street in the Point Loma area of San Diego. Jack is still a force in the sailing world, the champion of sailing as recreation for everyone. But modesty is another of his strong traits, and too few people know too little about his story and what it means.

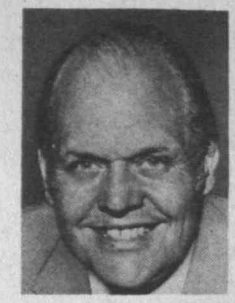
Aileen Kilgore Henderson is a free-lance writer in Northfield, Minn. A long-time sailing enthusiast, she made tape recordings of Mr. Wood's recollections as a resident of San Diego in 1975-80.



E.M. Drake



G.M. Keller



K.H. Olsen



A.N. MacDonald



B.M. Johnston



H.P. Aldrich

Selectors Selected

Four new members will join six incumbents on the Alumni Association's National Selection Committee this fall to pick candidates for officers of the association and alumni members of the M.I.T. Corporation to appear on the 1982 ballot.

The new members were elected by national ballot from a slate of 15 last spring:

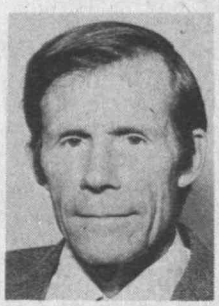
☐ **Elizabeth M. Drake,** '58, vice-president of Arthur D. Little, Inc., representing District I. She's been active in alumnae affairs, is a member of the Visiting Committee to the Department of Chemical Engineering, and was faculty resident on the East Campus from 1965 to 1971.

☐ **Coralee S. Kuhn,** '70, attorney of Silver Spring, Md., representing District V. A member of the District of Columbia Bar, Ms. Kuhn has been a leader in the M.I.T. Club of Washington since 1976.

☐ **Frank E. Carroll,** '44, president and chairman of Decks, Inc., and Carroll Research, Inc., Chicago. Mr. Carroll is a major figure in Chicago-area business, a former president of the Chicago Chamber of Commerce and the American Subcontractors Association, and he has filled all the major offices in the M.I.T. Club of Chicago since becoming a director in 1970.

☐ **Marianna P. Slocum,** '55, senior international program manager for the U.S. Department of Energy, representing District VII. Ms. Slocum, an officer of the M.I.T. Club of Washington, was a member of the Board of Directors of the Alumni Association from 1979-81.

Members of the Alumni Association with suggestions of new officers for the association should communicate with Richard A. Knight, secretary of the association (Room 10-110, M.I.T.) or with the chairman of the committee, Norman B. Leventhal, '38, president of the Beacon Companies, 1 Center Plaza, Boston.



W.F. Brace

Brace Named to Head Earth and Planetary Sciences

Carl I. Wunsch, '62, Cecil and Ida Green Professor of Physical Oceanography, has stepped down from his post as head of the Department of Earth and Planetary Sciences, to be succeeded by Professor William F. Brace, '46, an expert in the field of rock mechanics and structural geology. Professor Wunsch will return to teaching and research in ocean structure and circulation patterns.

Professor Brace's laboratory studies of rock deformation pointed the way to a major development in earthquake forecasting, and his influence is felt in geology laboratory procedures used throughout the world. He holds three degrees from M.I.T.—in naval architecture, civil engineering, and geology—and he has been a leader in the Technophysics Section of the American Geophysical Union; he holds the Rock Mechanics Award of the American Institute of Mining, Metallurgical, and Petroleum Engineers (1973).

Calendar of the Arts

Free copies of a monthly calendar of arts events and a newsletter on the arts at M.I.T. are available from the Council of the Arts at M.I.T., Room 20D-220. The listings include exhibitions, concerts, films, and dramatic performances for the month following publication of each issue.

Six Alumni in the Corporation Election

Four alumni new to its rolls will join the M.I.T. Corporation at its first meeting next fall, and two have been reelected to new terms as a result of votes at the Corporation's meeting preceding Commencement on June 1.

The four new members are:

☐ **Elizabeth M. Drake,** '58, vice-president of Arthur D. Little, Inc., where she manages the Risk Assessment Group. Dr. Drake's M.I.T. degrees are in chemical engineering, and she is a member of the Corporation's visiting committee to that department.

☐ **George M. Keller,** '48, chairman and chief executive officer of the Standard Oil Co. of California. Like Dr. Drake a graduate in chemical engineering, Mr. Keller is also a member of the visiting committee to that department.

☐ **Barbara M. Johnston,** '80, field engineer with the George Hyman Construction Co., Bethesda, Md. Ms. Johnson was nominated for Corporation membership by graduates in the three most recent classes; she received her S.M. in civil engineering at the Commencement Exercises on June 1.

☐ **Angus N. MacDonald,** '46, president of Angus MacDonald and Co., Inc., Greenwich, Conn. Mr. MacDonald's membership on the Corporation for 1980-81 is the result of his election earlier this year as president of the Alumni Association for the same one-year period. He's previously been a Corporation member for five years beginning in 1975.

Also at the meeting on June 1, **Kenneth H. Olsen,** '50, president of Digital Equipment Corp., was elected to life membership on the Corporation, having previously served two five-year terms starting in 1971. And **Harl P. Aldrich,** '47, co-founder and president of Haley and Aldrich, Inc., consulting geotechnical engineers and geologists, was named to a five-year term on the Corporation following his one-year membership in 1980-81 as president of the Alumni Association.



T.F. Jones

Thomas F. Jones, 1916-1981: "Influence Beyond Reckoning"

Thomas F. Jones, Sc.D.'52, vice-president for research at M.I.T. since 1975 who was president of the University of South Carolina from 1962 to 1974, died on July 14 after a long illness with cancer; he was 65.

Dr. Jones was one of M.I.T.'s senior statesmen, a national figure in education and research administration. In his tribute, President Paul E. Gray, '54, said Dr. Jones' "influence on educational institutions and on the profession of engineering goes beyond reckoning."

Dr. Jones first came to M.I.T. as a graduate student from Mississippi State University in 1939. He returned after World War II service with the Naval Research Laboratory to complete his graduate education and join the faculty, teaching electrical engineering until 1962 when he became head of the School of Electrical Engineering at Purdue. President Gray was among his students, and he recalls Dr. Jones' "gentle friendship, unfailing good humor, wisdom, and enthusiasm for life and learning." Indeed, Dr. Jones is said to have been influential in persuading Dr. Gray, as a young graduate student, to opt for an academic career which kept him at M.I.T. for a doctorate.

"Those, like myself, whose careers were shaped by our association with Tom have suffered an irretrievable loss," said Dr. Gray.

After leaving Purdue, Dr. Jones was president of the University of South Carolina for 12 years, and there, too, he won plaudits—especially for his management of racial integration and an enormous growth in budget, physical plant, and educational offerings. "The groundwork for much of what the university is regularly praised for today was laid by Dr. Jones during his highly distinguished term," said today's USC president, James B. Holderman, in a statement of tribute.

Dr. Jones had been vice-president of the Institute of Electrical and Electronic Engineers, president of the Southern Association of Land Grant Colleges and State Universities, member of the National Academy of Engineering, member of the National Science Board, fellow of the American Association for the Advancement of Science, vice-president of the American Society for Engineering Education, and member of the National Science Foundation Advisory Council.



J.B. Fisk

James B. Fisk, 1910-1981: Statesman and Manager of Science

James B. Fisk, '31, former president and chairman of Bell Telephone Laboratories who had been a member of the M.I.T. Corporation for 22 years and of its Executive Committee for a record 19 years, died on August 10 at his summer home in Keene Valley, N.Y. He would have been 71 on August 30.

Dr. Fisk's vital role in M.I.T. affairs during the last 40 years was made clear in the Institute's tributes. President Paul E. Gray, '54, spoke of Dr. Fisk's "unfailing willingness to provide considered advice, his broad perspective, and the soundness and wisdom of his judgment. These qualities . . . (were) paramount in those . . . pivotal discussions which he had as a trusted adviser to all the presidents in M.I.T.'s modern history."

James R. Killian, Jr., '26, wrote of Dr. Fisk's many services as a science adviser to the government as well as adviser to M.I.T.: "He has been one of my closest friends and a mainstay of M.I.T.'s governing body, . . . and we shall miss him sorely." And Howard W. Johnson, chairman of the Corporation, noted Dr. Fisk's participation "in extraordinary measure in the affairs of the Corporation and the Institute for more than a quarter of a century."

Perhaps most notably, Dr. Fisk had important roles in the selection of M.I.T.'s last three presidents; he was chairman of the committees which recommended Presidents Johnson and Wiesner to the Corporation, and he was a member of the committee that recommended Dr. Gray.

Dr. Fisk held two M.I.T. degrees: his S.B. was in aeronautics and astronautics, and he continued for a Ph.D. in physics (1935). He joined Bell Laboratories in 1939, became its president in 1959, was named chairman in 1973, and retired in 1974. Colleagues at the laboratories credit his effective management of scientists and their work with the steady stream of electronics inventions which emerged from that organization during the period of his leadership.

In addition to his service to the M.I.T. Corporation itself, Dr. Fisk was at various times a member of five of its visiting committees, including—at the time of his death—the committee on sponsored research. He was a founding life member of the M.I.T. Sustaining Fellows and was a major contributor to efforts by the Institute to secure corporate and foundation support.

In addition to his associations with M.I.T. and a number of corporate directorships, Dr. Fisk was a member of the advisory bodies to the New Jersey Institute of Technology, Harvard, the Guggenheim Foundation, and the Sloan Foundation. He held honorary degrees from 15 colleges and universities.

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J.G. Charney

Jule G. Charney, 1917-1981: A Major Figure in Theoretical Meteorology

Jule G. Charney, Alfred P. Sloan Professor of Meteorology who was a major world figure in the fields of dynamic meteorology and oceanography and a pioneer in numerical weather prediction, died on June 16 at the Sidney Farber Cancer Institute, Boston. He was 64.

When he was given the 38th William Bowie Medal of the American Geophysical Union in 1976, Professor Charney was cited as the scientist who had "guided the postwar evolution of modern meteorology more than any other living figure." Ten years earlier, receiving the American Meteorological Society's Carl-Gustav Rossby Research Medal, Dr. Charney was cited for research that "led the way to a more fundamental understanding of the atmosphere's general circulation and hydrodynamical instability, the structure of hurricanes, the dynamics of ocean currents, the propagation of wave energy, and many other aspects of geophysical fluid mechanics." He was, said the AMS, a significant contributor to "the study of meteorology as an exact science."

The son of Russian immigrants, Professor Charney was born in San Francisco and received three degrees from the University of California at Los Angeles. By 1948, after a nine-month visit with Carl-Gustav Rossby at the University of Chicago and a year at the University of Oslo, he was director of the Meteorological Research Group at the Institute for Advanced Study, Princeton, a post which he held until coming to M.I.T.'s project in atmospheric and ocean dynamics in 1956. Professor Charney was head of the Department of Meteorology from 1974 to 1977.

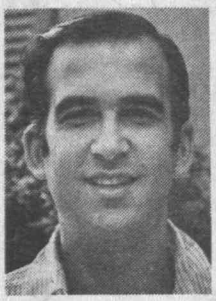
In addition to the awards already cited, Professor Charney held the Meisinger Award of the American Meteorological Society (1949), the Symons Gold Medal of the Royal Meteorological Society (1961), the Robert M. Losey Award of the Institute of Aeronautical Sciences (1957), the Hodgkins Gold Medal of the Smithsonian Institution, and the Cleveland Abbe Award of the American Meteorological Society (1980) for "scientific leadership of the Global Atmospheric Research Program."

Deceased

Suren Stevens, '11; June 3, 1981; 27 Skahan Rd. Belmont, Mass.
Alton A. Cook, '15; July 1980.
Edward A. Graustein, '16; July 13, 1981.
Herbert L. Duffy, '19; June 10, 1981; P.O. Box 917, West Dennis, Mass.
Francisco L. Lazo, '21; 1969.
Carl A. Burdick, '22; May 24, 1981; 11 Bowman Dr., Greenwich, Conn.
Harold D. Stanley, '22; February 1978; 4932B Eaglewood Rd., Boynton Beach, Fla.
Herman A. Bruson, '23; May 31, 1981; 98 Ansonia Rd., Woodbridge, Conn.
Frank R. Shaw, '24; July 11, 1981; P.O. Box 94, Babson Park, Mass.
Sir Arthur Tyndall, '24; March 6, 1981.
Garvin A. Drew, '25; July 10, 1981; 31792 Isle Royal Dr., Laguna Niguel, Calif.
Donald G. Vaughan, '25; May 24, 1981; 29 Neptune Dr., Groton, Conn.
Mann Chun Chan, '26; March 6, 1981.
Manuel R. Castellanos, '27; May 31, 1981; 2914 Valley Forge St., Sarasota, Fla.
Douglas A. Tooley, '28; June 11, 1981; 16599-7 Caminito Vecinos, San Diego, Calif.
Kendrick F. Bellows, '29; July 26, 1981; Nepawin Ln., Plainfield, N.J.
Clyde W. Tirrell, '30; February 10, 1981; 929 Orma Dr., San Diego, Calif.
Charles W. Steinbach, '32; November, 1980; 4373 29th Pl. SW, Suite P, Naples, Fla.
Louis J. Vassalotti, '32; April 30, 1981; Box 755, 14 Cove Rd., North Falmouth, Mass.
Harry E. Allen, '33; May 30, 1981; 428 So. Spring Ave., La Grange, Ill.
John B. Sbrega, '33; July 20, 1981; 264 Linden Ave., Holyoke, Mass.
Stanley B. Smith, Jr., '36; June 1, 1981; 52727 Brookdale Dr., South Bend, Ill.
Loring C. Farwell, '37; April 6, 1981; 735 Happ Rd., Northfield, Ill.
Howard J. McCrodden, '39; 1979.
Thomas F. Jones, '40; July 14, 1981; 1644 Kathwood Dr., Columbia, N.C.
Rita M. Kelley, '41; July 22, 1981; Jamaicaway Tower, 111 Perkins St., Jamaica Plain, Mass.
William J. Ozeroff, '42; June 29, 1981; 6428 Avenida Manana, La Jolla, Calif.
Thomas S. King, '45; May 28, 1981; 6630 McLean Ct., McLean, Va.
A. Robin Mowlem, '46; 1978; 16 Panessa Dr., Poughkeepsie, N.Y.
John R. Lamarsh, '48; July 26, 1981; 68 N. Chatsworth Ave., Larchmont, N.Y.
Ludwig Katz, '49; March 18, 1981; 33 Gale Rd., Swampscott, Mass.
Charles T. Freedman, '56; July 19, 1981; State Rd., RFD #1, Plymouth, Mass.
R. Bruce Miller, '56; July 4, 1981; 11405 North Greyston, Oklahoma City, Ok.
William A. Martin, '60; June 2, 1981; 11 Abbotsford Rd., Brookline, Mass.
Hassan S. Mohamed, '60; 1974.
Robert E. Conary, '61; 1980.
William E. Robinson, '61; December 23, 1980; 508 E. 39th St., Baltimore, Md.
William A. Keeler, '63; July 1981; 4607 Ridgeside, Dallas, Tex.
Howard E. Kirkendall, '64; June 5, 1981; 317 Beechmont Dr., New Rochelle, N.Y.
Gustav Dick, '65; April 10, 1980; 3364 Park 16th, Moline, Ill.
James L. Nash-Webber, '68; July 10, 1981; 60 Bartlett Ave., Arlington, Mass.
Edwin P. Ziemba, Jr., '78; June 7, 1981; 90 Maple St., Malden, Mass.

Puzzle Corner
Allan J. Gottlieb

A Small Loss of $26 \cdot 10^{-21}$



Allan J. Gottlieb, '67, is associate research professor of mathematical sciences at the Courant Institute of Mathematical Sciences of New York University; he studied mathematics at M.I.T. and Brandeis. Send problems, solutions, and comments to him at the Courant Institute, New York University, 251 Mercer St., New York, N.Y. 10012.

Since the October issue begins a new volume of *Technology Review*, we take this chance to explain the ground rules of "Puzzle Corner" every year.

In each issue we present five regular problems (the first of which is chess- or bridge-related) and two "speed" problems. Readers are invited to submit solutions to the regular problems, and three issues later one submitted solution is printed for each problem; we also list other readers whose solutions were successful. In particular, solutions to the problems you see below will appear in the February/March issue. Since I must submit that column sometime in November (today is July 20), you should send your solutions to me during the next few weeks. Late solutions, as well as comments on published solutions, are acknowledged in the section "Better Late Than Never" in subsequent issues.

For "speed" problems the procedure is quite different. Often whimsical, these problems should not be taken too seriously. If the proposer submits a solution with the problem, that solution appears at the end of the same column in which the problem is published. For example, solutions to the October "speed" problems are given below. Only rarely are comments on "speed" problems published or acknowledged.

There is also an annual problem, published in the first issue of each new year; and sometimes we go back into history to republish problems which remained unsolved after their first appearance.

All problems come from readers, and all readers are invited to submit their favorites. I'll report on the size of the backlog, and on the criteria used in selecting problems for publication, in a future issue.

Problems

OCT 1 We begin this issue with a bridge problem from Doug Van Patter:

North:
♠ J 10 5 2
♥ 8 6 2
♦ 7 6 5 4
♣ K J

South:
♠ A K
♥ A K Q 5 4 3
♦ A 8 3
♣ A 9

East opens with a weak two-diamond bid (usually six cards, sometimes only five). Your (South) final contract is six hearts. The opening lead: ♦ 2. Problem: What line of play gives you the best chance of making this slam, after finding out that West has three trumps?

OCT 2 David Steyert would prefer a noncalculus solution to his cow problem: A cow is tethered to a circular silo in such a manner that the distance from the cow's mouth to the fixed tie-point is exactly 10 meters. If the circumference of the silo is exactly 20 meters, how much grazing area does the cow have?

OCT 3 Bill Bezdecheck wants to find an integer having the property that moving the rightmost digit to the leftmost slot yields a number exactly nine times the original number. For example, 2017 does not work since 7201 does not equal 9·2017.

OCT 4 In the best tradition of collegiate mathematics, Josh Cohen sends us a beer-theoretic problem posed by

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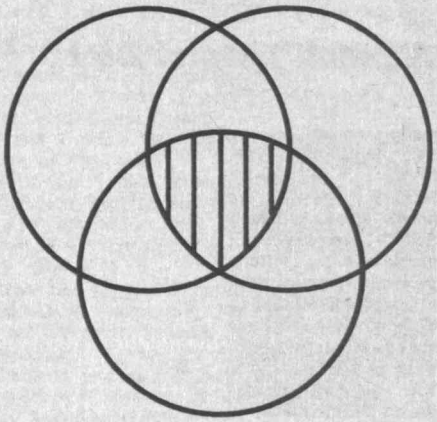
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the M.I.T. Math Club: The familiar Ballantine Beer logo (pictured below) consists of three circles of equal radius placed so that the center of each circle lies on the boundaries of each of the other two. With elementary geometry or calculus it is easy to find that the area of the region of intersection is
$r^2(\pi - \sqrt{3})/2$,
where r is the radius of the circles. Consider the three-dimensional analogy: find the volume of the region of intersection of four spheres of radius r, each of which has its center on the surfaces of the other three.



OCT 5 Harry Zaremba is interested in an extension of the classical Pythagorean triple. He notes that a positive-integer solution to the pair of Pythagorean relations $A^2 + B^2 = C^2$ and $(A + 3)^2 + (B + 3)^2 = (C + 4)^2$ is the trivial triple (A,B,C) = (0,1,1). Can you find two other positive-integer solutions? Determine if there are a finite or infinite number of such solutions.

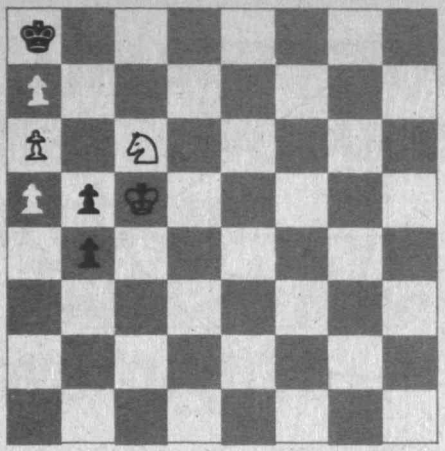
Speed Department

OCT SD 1 James Landau recalls his Army days: In the U.S. Army, a unit preparing to march forms a rectangular "rank and file" formation that is four files wide and as many ranks deep as needed. The distance between adjacent ranks is 30 inches. When marching, each man takes 120 30-inch steps per minute. Problem: the 1,764 men of his company were formed up on the parade ground at Fort Myer and Major Purdy, at the head of the formation, gave the order, "Forward, march!" As the company passed the reviewing stand, how long was the formation?

OCT SD 2 William Katz wants to know what is the smallest number of matches that will determine a winner in a club tennis tournament that has 43 entries, some of whom must be seeded because of ratings?

Solutions

MAY 1 White to play and mate in two moves:



Rick Tavan not only solved the problem but compared it with another from *Chess to Enjoy*. His solution is:

1. P x P P—N6
2. P—N7 mate

made possible because Black's last move had to be

0. . . . P—N4

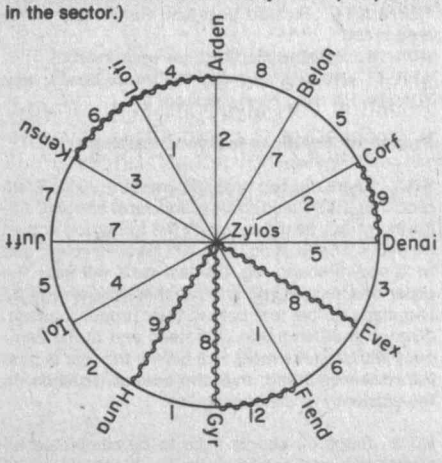
Rick then went on to write, "Interestingly, about an hour after I worked the problem I was reading Andy Soltis' *Chess to Enjoy* and encountered a similar problem in the last chapter of the book. The *en passent* capture appears at first glance to be the solution with identical reasoning as to Black's previous move. Further analysis shows that the two-square Pawn move could not have happened because a White Bishop is on QR1. In fact, Black could not have just moved. The problem is captioned "White mates in one" and the key is that Black must be on move! After Black's only legal move, a Queen mate is obvious. The theme of your problem is the red herring of this one."

Also solved by Robert Schmidt, John Cronin, Elliot Roberts, David Freeman, Daniel Seidman, Rufus Franklin, Larry Shiller, Richard Hess, Matthew Fountain, Winthrop Leeds, A. Ostapenko, and the proposer, George Farnell.

MAY 2 The Starship Enterprise is conducting negotiations on Arden with the Emperor of the Zylos System. Suddenly there is an alarm: a Klingon warship has entered the sector. The Enterprise must gather all of the leaders of the 12 outer planets and bring them to a conference on Zylos. It must use only the established space routes, whose travel times in zorpets are indicated in the chart. How soon can the conference be held?

Commander Michael Jung reports:

The first step is to locate the "forbitten" space routes, where a pair of connecting routes to the same destination may be traversed in fewer zorpets than the forbidden route itself. (Star Fleet Standing Order #HQ-3-2179-001 prohibits travel over "forbidden routes" when an enemy warship is present in the sector.)



Now our path is simple: we simply go clockwise around the rim, returning to the center (Zylos) wher-

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ever necessary to avoid a forbidden route. Thus the quickest sequence becomes the following, a total of 57 zorpets:

Arden	Huna
Beloh	Gyr
Corf	Huna
Zylos	lol
Denai	Juft
Evex	Kensu
Flend	Zylos
Zylos	Loti
lol	Zylos

Since, as everyone knows, it takes a Klingon warship exactly 61.374268 zorpets to travel from the edge of a sector to the central planet, there will be plenty of time to plan strategy.

Also solved by Matthew Fountain, Jordan Wouk, David Freeman, Avi Ornstein, Harry Zaremba, Naomi Markovitz, W. Smith, Marlon Weiss, Richard Hess, Larry Shiller, A. Ostapenko, and Winthrop Leeds.

MAY 3 What is the sum of $1^{-1} + 2^{-2} + 3^{-3} + \ldots$?

Apparently no one could find a closed-form solution. Of all the approximations given, John Wrench claims the most accuracy (25 decimal places):
1.29128 59970 62663 54040 72826.
Richard Hess only calculated 21 places but got:
1.29128 59970 62663 54038 1.
Well, gentlemen, what about the missing $26 \cdot 10^{-21}$?

Also solved by Winslow Hartford, Matthew Fountain, Winthrop Leeds, and Larry Shiller.

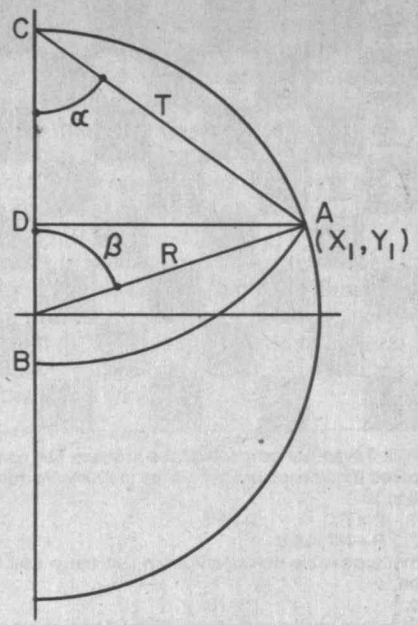
MAY 4 The proposer explained his interest in constructing N-by-N matrices of letters such that each row is an N-letter English word (read from left to right) and so is each column (read from top to bottom). Such a matrix is called N-perfect if the 2N words are all distinct. Problem: What is the largest possible N-perfect matrix?

Marlon Weiss found several four-perfect squares and Winthrop Leeds found a five-perfect square. Larry Shiller refers us to *Games* magazine and Edwin McMillan and Matthew Fountain suggest *Language on Vacation* by Dmitri Borgman. Finally, Mary Hazard sent us the following:
"Word squares" such as Barie Gilbert describes as "N-by-N matrices" have been a pastime for word-puzzle addicts known as "formists" (those who create word forms—a square is just one of many forms these crossword-like structures can take; there are diamonds, rhomboids, pyramids, etc.) for at least 100 years. Recently, a young Minnesotan by the name of Blake Greenlee created a 7-by-7 double word square (a double square is one in which the words across are different from those down, thus making 14 different words in the square) which was published in *The Enigma* (1980). Unfortunately, this word genius died at the untimely age of 25 this year; we regretfully will see no more such output from his active mind. Greenlee's 7-by-7 square is:

S C A B A R D
M A R I N E R
A M I R A T E
S P E C T E D
H A T H I N G
E N T E N T E
S E E R E S S

All of these words are in the *Oxford English Dictionary* or the second or third editions of *Webster's New International*. Other formists have in the past made 8-by-8 double squares, but some of the components are two-word phrases (dictionary entries, all right, but usually pretty odd words). Mr. Greenlee did many 6-by-6 double squares, and his is not the only 7-by-7 double square extant.

MAY 5 A farmer rents out one half of a circular, fenced pasture. A cow is to be tethered to a point on the fence so that she is able to graze on exactly one half of the pasture area. What is the length of the tether (T) if the radius (R) of the pasture is 100 feet?



The following solution is from William Moody. Referring to the accompanying sketch, the area of segment BAD: $\frac{1}{2}\alpha T^2 - \frac{1}{2}x_1(R - y_1)$, and area of segment CAD: $\frac{1}{2}\beta R^2 - \frac{1}{2}x_1y_1$, where $\alpha = \sin^{-1}(x_1/T)$, $\beta = \sin^{-1}(x_1/R)$, and $x_1 = T\sqrt{1 - T^2/(4R^2)}$. Twice the sum of the segments must equal $\pi R^2/2$, so that $T^2 \sin^{-1}\sqrt{1-T^2/(4R^2)} + R^2 \sin^{-1}(T\sqrt{1-T^2/(4R^2)}) - RT\sqrt{1-T^2/(4R^2)} - \pi/2 = 0$. To simplify the writing, let $T = uR$ and $v = \sqrt{4-u^2}/2$, so that: $u^2 \sin^{-1}v + \sin^{-1}(uv) - uv - \pi/2 = 0$. The solution to this transcendental equation is approximately: $u = 1.158728473$. With $R = 100'$ the tether length is a bit less than 115′ 10½″. Practically, of course, the tether must be somewhat shorter since the cow will be able to reach a foot or so beyond the end of her rope as she grazes.

Also solved by Michael Jung, Richard Farber, L. Upton, Larry Shiller, Edwin McMillan, Mary Lindenberg, Edward Dawson, Matthew Fountain, John Wrench, Richard Hess, Jordan Wouk, David Freeman, Herman Friedlaender, John Prussing, Norman Wickstrand, Larry Bell, Raphael Justewicz, Winslow Hartford, Harry Zaremba, and Emmet Duffy.

Better Late Than Never

FEB/MAR 1 Gerald Blum, Richard Hess, and Winslow Hartford have responded.
FEB/MAR 2 Richard Hess, Gerald Blum, Winslow Hartford, Harry Zaremba, and Donald Savage have responded.
FEB/MAR 3 Gerald Blum and Richard Hess have responded.
FEB/MAR 4 Michael Jung, Gerald Blum, Richard Hess, and Winslow Hartford have responded.
FEB/MAR 5 Richard Hess and Gerald Blum have responded.
APR 1,4 Winslow Hartford has responded.
APR 5 Naomi Markovitz, Winthrop Leeds, and Winslow Hartford have responded.

Proposers' Solutions to Speed Problems

SD 1 There are two possible answers. *First*, 1,105 feet. The 1,764 men form a first rank and 440 following ranks; hence in theory the formation should be 440 • 2.5 feet long, or 1,100 feet. However, due to speed-of-sound lag, the last rank will hear the order one second late and will therefore always be two steps or five feet behind their proper location. *Second*: Indeterminate. The head end of the company will be in the mess hall before the rear is past the reviewing stand; thus the answer depends on the efficiency of the serving line.

SD 2 Since 42 people have to be eliminated no matter how you seed or arrange, there will be 42 matches (one person being eliminated in each match).

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Anthony D. Kurtz, 1951
Ronald A. Kurtz, 1954

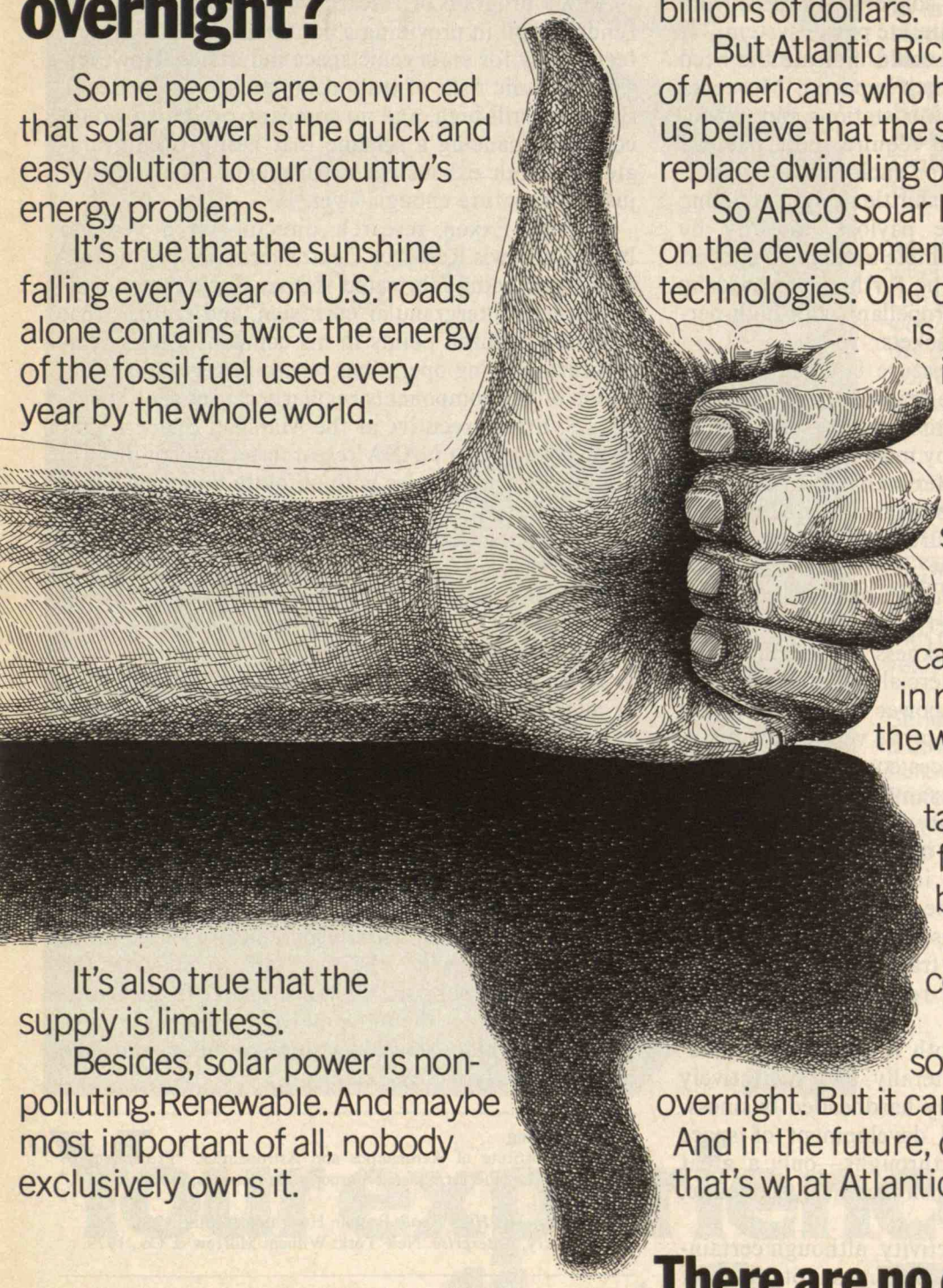
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There are no easy answers.

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Small self-contained payloads, "getaway specials," can be flown on the shuttle for as little as $3000.

The 250-kilowatt power module could also begin key series of space-based experiments on the transmission to earth of electricity converted in space from solar energy, the so-called "satellite power system." If successful, such experiments could indicate the need by the 1990s for greater launch capacity. Moreover the building of prototype power stations and expansion of industrial uses would require more payload capacity. Initial projections for such "space freighters" are based on the current shuttle design—tripling the 30,000-kilogram shuttle payload capacity by replacing the orbiter with a simple unmanned carrier. The shuttle's payload could be further increased by replacing the present solid-propellant with high-performance liquid-propellant rockets.

One desperately needed feature is a high-performance upper-stage vehicle to transfer payloads from the shuttle's low-earth orbit to higher orbits, such as the geostationary orbit used by most communications satellites. This orbital-transfer vehicle (nicknamed "space tug") was part of the original shuttle design but was one of the first features dumped, to almost everyone's subsequent sorrow, during the the early penny-wise, pound-foolish budget-cutting exercises. The European Ariane launcher, meanwhile, is capitalizing on this upper-stage weakness by offering more advantageous terms to commercial customers.

Should space-based solar power stations or other massive space-based industry prove viable, raw materials from nonterrestrial sources could be utilized for in-space construction. For example, the energy required to attain escape velocity for a ton of minerals from the moon, where Apollo astronauts found ample supplies of titanium, silicon, iron, and a number of other useful metals, is only one-twentieth that needed to lift a ton off the earth. Thus, the high initial investment in lunar mining and transportation facilities could pay off in significantly reduced transportation and environmental costs.

Nonterrestrial options—both in terms of production and resources—may literally and figuratively seem way out to a good many hardheaded businesspeople. But the commercial development of space requires few scientific breakthroughs—only a great deal of engineering—to establish technical, economic, and environmental viability.

Space-based commercial activity, although certainly promising compared with the almost total lack of interest by nonaerospace companies a few years ago, represents only a small fraction of what space proponents expect to be forthcoming. The pump has only been primed, and federal involvement is essential if progress is to continue. Although sadly underfunded, NASA's program of research on space processing is fundamental in providing a continuing source of new technology for embryonic space industries. However, the economic risks of truly commercial enterprises in space are still high, and no company executive would consider financing a scheme that hasn't been evaluated through exhaustive experiments. The industry just isn't mature enough—yet.

But an Exxon research director on a visit to NASA's Lewis Research Center sees a jet-engine turbine blade being fabricated from a single metal crystal without intergranular corrosion, and realizes that there are a dozen points in his company's high-temperature refining operations where intergranular corrosion of key components regularly causes shutdowns. A U.S. Steel executive at the Marshall Space Flight Center watches a NASA research technician distribute molten tin globules with absolute uniformity in a niobium-based superconductor and begins to wonder—could he adapt this to his company's process? A Sohio chemist's eyebrows almost meet his hairline as he watches new microthin polymer coatings being applied smoothly and routinely to photovoltaic cells at the Jet Propulsion Laboratory.

These aren't future technologies—they can be used or adapted today. According to Dr. Norman Lillybeck, director of materials development at John Deere & Co., "Five or six of the [NASA] technology items we observed should gain my company three to five years on our previously expected progress."

There seems little doubt that such development will be undertaken; the only uncertainty is the rate at which commercialization will occur. After all, the shuttle represents our first economically viable move into space. But while the marketplace must be the primary force, support (or nonsupport) from Washington may direct the outcome. The previous administration certainly slowed the tempo; the current one can profoundly increase it.

Further Reading

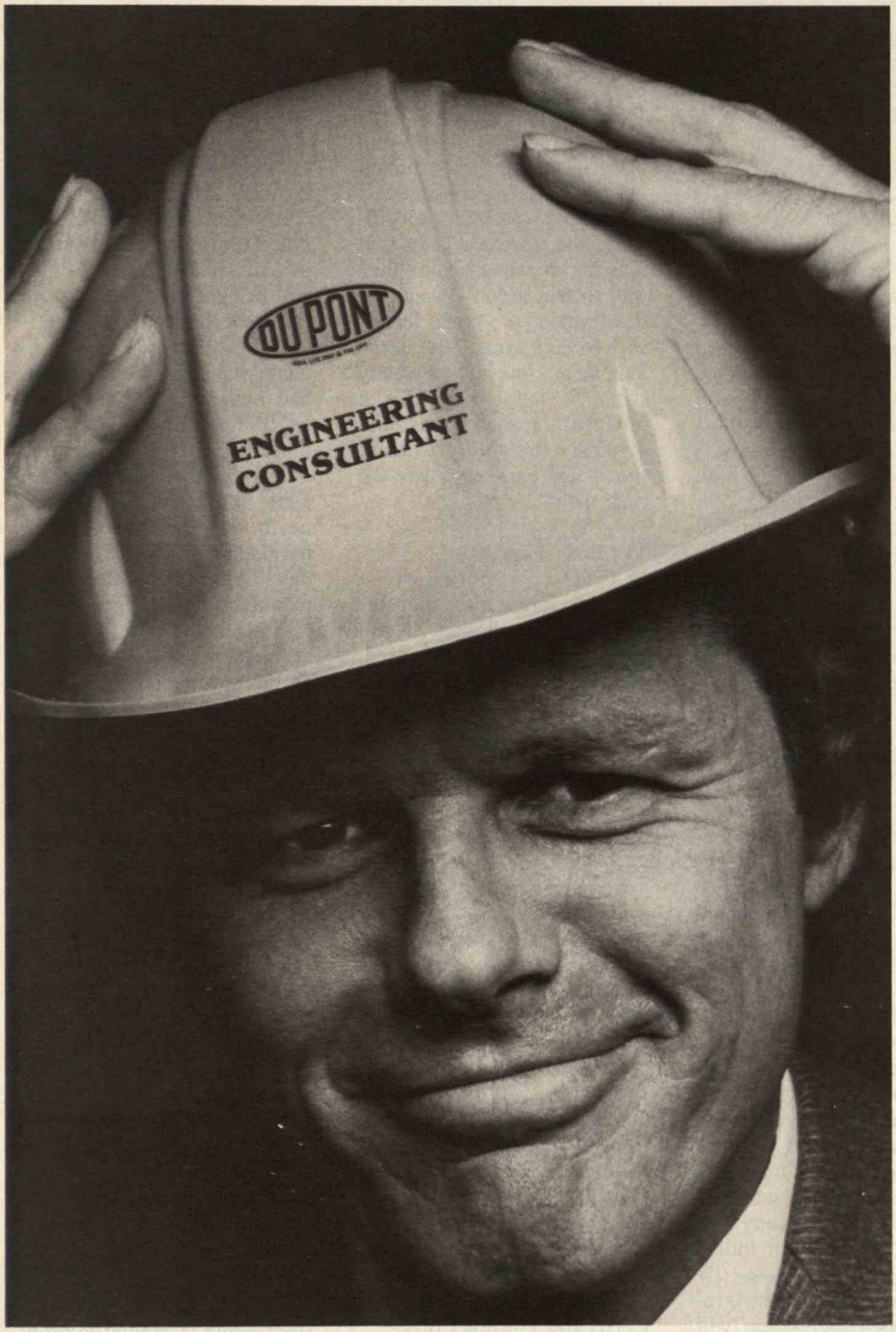
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Grey, Jerry, *Enterprise*. New York: William Morrow & Co., 1979.

Jerry Grey, Ph.D. is public-policy administrator of the American Institute of Aeronautics and Astronautics and vice-president of the International Astronautical Federation. His latest book, *Beachheads in Space*, will be published by Macmillan in 1982.

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The Japanese Empire Strikes Back

by Masayoshi Kanabayashi

Now that the U.S. has successfully flown its space shuttle, it's just a matter of time before the Japanese launch their own, smaller *Columbia* and begin exporting it to the U.S.

So went a joke that made the rounds in Tokyo recently. As it happens, though, the joke contains at least a kernel of truth. It's still a sketch on a drawing board, and it isn't likely to take off until the 1990s, but Japan is indeed mulling a possible "mini" space shuttle.

"Just as we need a bus, we also need a mini-car," says a spokesman for Japan's National Space Development Agency (NASDA), a government-sponsored corporation charged with putting Japan's budding space program into effect.

The mini-shuttle, which hasn't been officially authorized by the government yet, is just one part of that program. Since 1970, Japan has put 22 satellites into orbit, but three of them had to be launched for Japan by the U.S. National Aeronautics and Space Administration because Japan lacks rockets with sufficient power for heavy satellites.

So one thrust of Japan's space program is building bigger rockets. Last February it launched one that can carry 770 pounds, and it is developing one capable of carrying a 1,100-pound satellite into orbit.

Another project is the mini-shuttle. Although smaller than *Columbia*, it would have most of the U.S. shuttle's basic functions, including jet engines that would enable it to land in Japan for reuse. On the blueprints, the mini-shuttle measures 46 feet long and 24.5 feet wide, weighs 10 tons, and can carry a crew of four plus 1,100 pounds of cargo.

Because It's There

Why does Japan need a space program in the first place? The answer seems to be part national pride, part a calculation that the technology developed by a space program will be critical to Japan's economic future. There is a feeling here that Japan, with its almost total lack of natural resources, has staked its future on high technology to such an extent that it can't afford to fall behind in critical technological areas. What supports the feeling is the realization that in downgrading its military as it has, Japan already lags in weapons technology.

"The present outer space is just like a virgin land in the sailing ship era," declares a pamphlet issued by NASDA. "If other countries get patent licenses on new materials made in space or obtain medicine that is good enough to meet the world demand in small quantity, the impact on Japan will be great."

Moved by sentiments like those, Japan's Ministry of International Trade and Industry has begun taking steps to transform Japan's space program from a loosely organized network of research projects into an industry. Its first step, taken last fall, was to set up an advisory body to study the prospects for such an industry.

And the advisory body recently concluded: space will be a $4.5-billion industry for Japanese manufacturers by the mid-1990s, comparable in size to today's radio and television manufacturing industry. Moreover, the advisory body recommended that the Japanese space industry "aim at the world market," and urged that the government "provide active assistance." Regarding satellites specifically, the advisory body said that for the time being, "one way to win orders" would be to develop products jointly with foreign firms. "But in the long term," the advisory body said, "it is desirable for a group of Japanese companies to obtain the ability to enter the world market solely on their own."

The Long View

If the Japanese space industry accomplishes all that, it will have come a long way indeed. Today, although some 70 Japanese companies do space work, sales are less than $480 million—about the size of Japan's underwear industry. Exports constitute about 20 percent of the industry's current sales, but most of that is ground-station equipment, such as antenna systems. The rest is sales to the Japanese government for use in broadcasting, weather forecasting, resource surveying, and other programs.

Of the 70 companies, 6 account for two-thirds of the annual business and are likely to be among the mainstays of the industry's future. They are Mitsubishi Heavy Industries Ltd., Nippon Electric Co., Ishikawajima-Harima Heavy Industries Ltd., Nissan Motor Co., Mitsubishi Electric Corp., and Toshiba Corp.

Company officials say none of the Japanese concerns is currently making money on its space business. They say the main priority is to increase technological prowess by taking part in the space program.

Launching rockets, for example, isn't a commercial business today, but when it does become one, says Yoshihide Hiraiwa, senior manager of Mitsubishi Electric, Japan will bring a great strength to the international competition—its ability to make high-quality products. "If Japan had manufactured the *Columbia*, the tiles would never have fallen off," Mr. Hiraiwa says.

In the future, Mr. Hiraiwa believes, the U.S. will continue to lead the free world in developing new space technology. But a good deal of the manufacturing, he hopes, will take place in Japan.

Everyone, to be sure, isn't as optimistic about the Japanese space industry's future as the advisory body and Mr. Hiraiwa. Many company officials insist that it will be more difficult for Japan to excel in an industry that, unlike auto and television manufacture, isn't geared toward mass production. Only two or three rockets are launched in Japan each year.

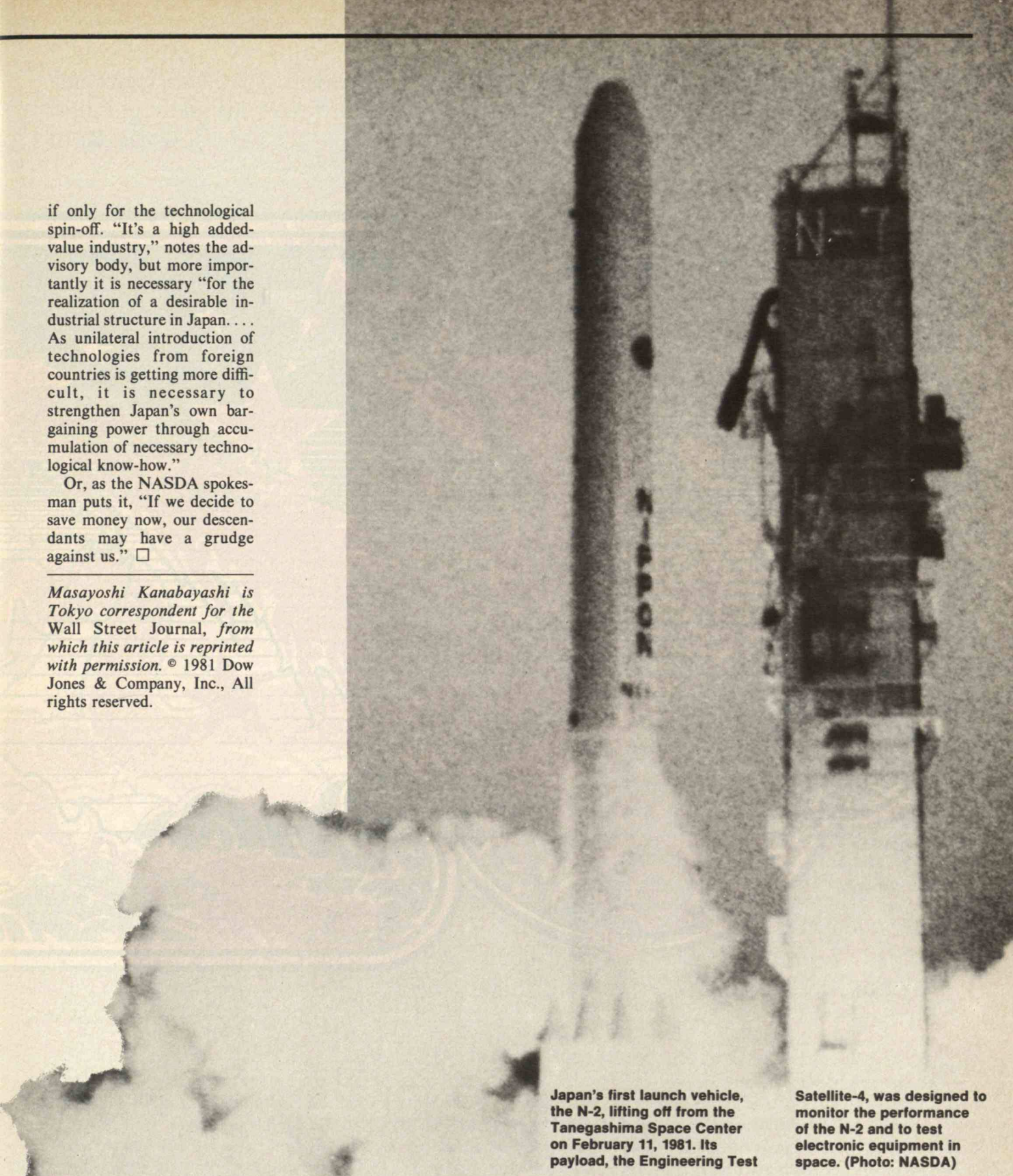
But other space industry proponents dismiss such pessimism. Someday, space could be a mass-production industry, they maintain. And although Japan is currently five to ten years behind in the space race, a NASDA official notes that "Japan has come through holes in the net of American technology in the past (in such sectors as automobiles and electronics), so there could be similar holes in the future as well."

But the way some Japanese talk, it seems likely that Japan will pursue its space program

if only for the technological spin-off. "It's a high added-value industry," notes the advisory body, but more importantly it is necessary "for the realization of a desirable industrial structure in Japan.... As unilateral introduction of technologies from foreign countries is getting more difficult, it is necessary to strengthen Japan's own bargaining power through accumulation of necessary technological know-how."

Or, as the NASDA spokesman puts it, "If we decide to save money now, our descendants may have a grudge against us." □

Masayoshi Kanabayashi is Tokyo correspondent for the Wall Street Journal, *from which this article is reprinted with permission.* © 1981 Dow Jones & Company, Inc., All rights reserved.



Japan's first launch vehicle, the N-2, lifting off from the Tanegashima Space Center on February 11, 1981. Its payload, the Engineering Test Satellite-4, was designed to monitor the performance of the N-2 and to test electronic equipment in space. (Photo: NASDA)

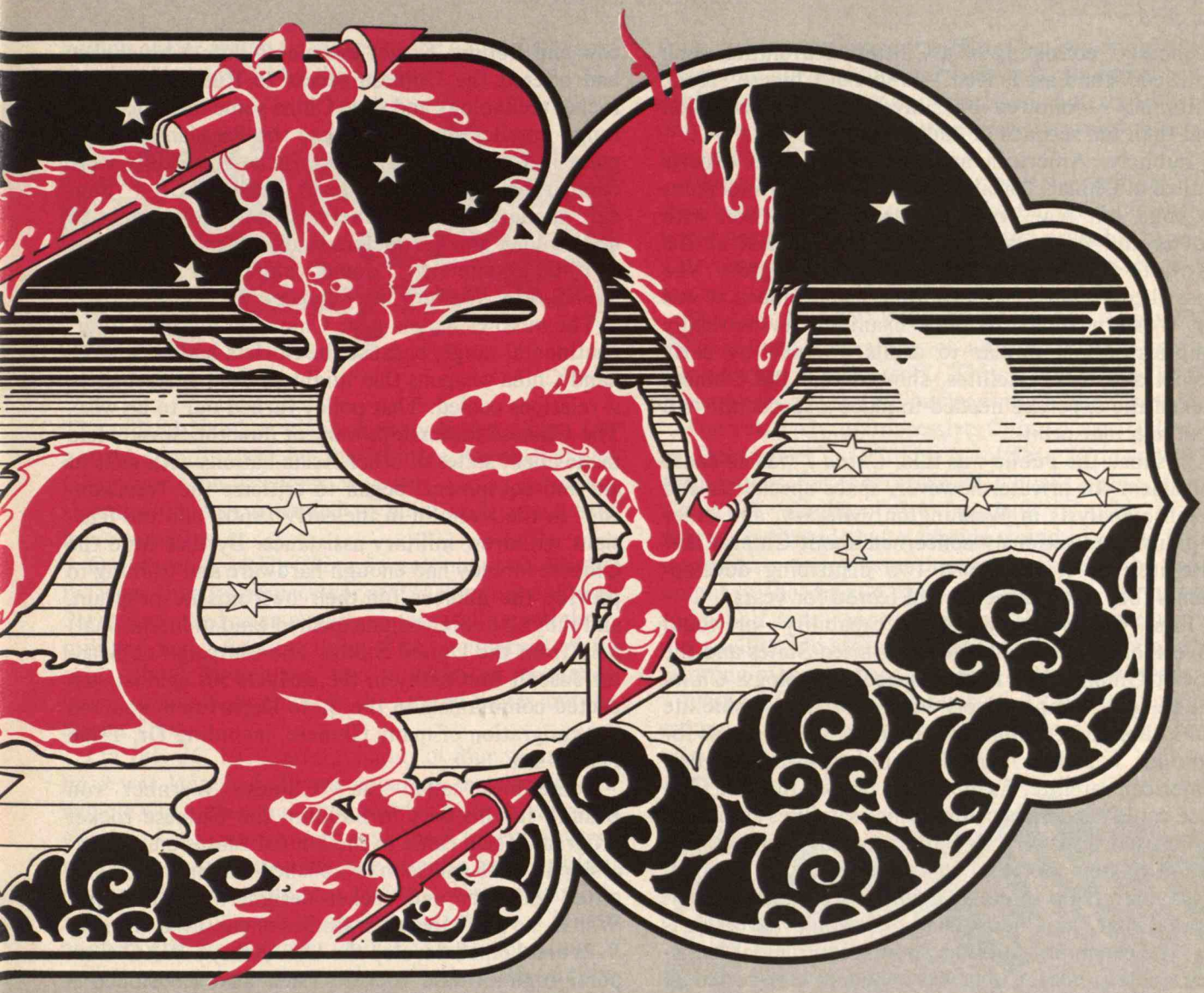


MICHAEL COBB

Dragon in the Sky: China's Space Program

by David Ritchie

China has engineered a series of successful satellite launches since 1970, building along the way the capability to launch ICBMs. But peaceful uses of this technology, in cooperation with the West, appear to be among China's first priorities.



For more than a decade after the launch in 1957 of the first artificial earth satellite, Russia's *Sputnik 1*, the Soviet Union and the United States had outer space virtually to themselves. These countries had a commanding lead in virtually all aspects of space technology and controlled the launch vehicles needed to place heavy payloads into orbit.

Except for each other, the two superpowers faced no serious competition in outer space until the spring of 1970. (Only two other nations had by then successfully orbited satellites: France in 1965, and Japan in early 1970.) Then on April 24 a multistage, liquid-fueled rocket took off from a launch site at Shuang Ch'eng-tze in Outer Mongolia, about 1,400 kilometers due west of Beijing. The rocket lifted into orbit a 173-kilogram satellite designated *China 1* or *Mao 1* by Western intelligence agencies.

The orbit of *China 1* was inclined about 68 degrees to the equator and had an apogee (maximum altitude) of about 2,400 kilometers and a perigee (minimum altitude) of 439 kilometers. Its telemetry was, to say the least, unusual. *China 1* broadcast one-minute

Ironically, the Soviets,
who had the most to fear from Chinese ascendency to space,
had done more than anyone else
to make it possible.

"concerts" consisting of a Cultural Revolution song entitled "The East Is Red"—a sort of Chinese "Rule, Britannia"—followed by a five-second intermission and then ten seconds of audio signals.

Publicly, American and European space experts smiled at China's "orbiting music box" and took pains to point out how crude it was in comparison with Soviet and American satellites. One analyst at the Institute for Defense Analyses in Arlington, Va., described *China 1* as "primitive," and indeed it was by Western standards. For example, its markedly elliptical orbit, similar to orbits attained by early Soviet and U.S. satellites, showed that the Chinese lacked the expertise needed to place a spacecraft in a neat, circular orbit.

In short, the public was told, *China 1* was no cause for alarm. In private, however, space specialists and defense analysts in Washington, Moscow, and other capitals were seriously concerned about China's new satellite, for it confirmed two disturbing developments they had suspected and feared for years.

First, China clearly had the capability—or would have shortly—to challenge the United States and the Soviet Union in the field of space technology. *China 1*'s weight, comparatively heavy for a first satellite (173 kilograms, compared with only 84 kilograms for *Sputnik 1* and a mere 14 kilograms for the first American satellite, *Explorer 1*), proved that the Chinese could send up reconnaissance satellites similar to those used in America's Satellite and Missile Observation System (SAMOS) in the near future. Second, and of strategic interest, *China 1*'s success demonstrated that the Chinese had—or would have shortly—the capability to build an intercontinental ballistic missile (ICBM). China was known to have tested an atomic device in 1964.



rom Russia: A Boost

Ironically, the Soviets, who had the most to fear from the Chinese ascendency to space, had done more than anyone else to make it possible. In the late 1950s, during a brief spell of warm relations between Moscow and Beijing, Soviet Premier Nikita Khrushchev had offered the Chinese access to Russian military rocket technology and gave China some intermediate-range missiles similar to those the Russians tried to place in Cuba in 1962. Those rockets probably were comparable in size and range to the Soviet SS-4 "Sandal," a one-stage liquid-fuel missile approximately 23 meters long and 1.7 meters in diameter with a range of 1,400 kilometers ("Sandal" is the code name given the SS-4 by Western intelligence).

The missiles Russia gave China did not have intercontinental range, because the Soviets had no wish to hand China weapons that might be used against them if relations cooled. That policy turned out to be wise. The Chinese leadership, wary of how the Soviets had made client states of other Asian nations with gifts of aid and equipment, began to criticize the "revisionists" in the Kremlin in the early 1960s, and the Russians withdrew military assistance. By that time the Chinese already had enough hardware and training to provide the nucleus for their own missile program, and they also received unexpected (and unintentional) help from the United States. The campaign of Senator Joseph McCarthy in the early 1950s against suspected communists in the State Department spurred the emigration of many Chinese, including Dr. Tsien Hsueh-sen.

Sometimes called the "Chinese Wernher von Braun" for his part in building the Chinese rocket program, Tsien came to the United States on a scholarship in 1935 and soon established his reputation as a gifted engineer and rocket designer. After World War II, he participated in studies of captured German V-2s and helped develop the U.S. Army's WAC-Corporal high-altitude rocket. Tsien also envisioned a winged rocket, similar to the modern NASA space shuttle, that would have glided back to earth from outer space—an idea that also occurred to von Braun when he was working with the Nazi rocket laboratory at Pennemunde.

A few years after Tsien's return to China in 1955, the Cultural Revolution convulsed China's scientific establishment. Thousands of scientists, engineers, and other intellectuals were removed from their labs and classrooms and sent to work as field laborers, setting Chinese science back several decades.

Nonetheless, rocket research continued in China. In 1966 a rocket capable of carrying nuclear warheads 650 kilometers was tested successfully at Lop Nor. This achievement made it clear that Beijing would soon have an orbital launch capability, most likely by

adding one or two extra stages to the liquid-fuel rockets already provided by the Soviets.



Great Leap Upward

The official Hsinhua News Agency hailed *China I* as a great step forward for the Chinese Revolution and Chairman Mao Tzedong, who was quoted as saying that the Chinese intended to build and launch still more satellites.

On March 3, 1971, *China 2* went into orbit. Slightly larger than its predecessor at 221 kilograms, *China 2* was described as an experimental satellite with both military and scientific tasks. The inclination of its orbit, about 70 degrees, was suitable for reconnaissance, taking it over most of the United States and the Soviet Union.

On July 26, 1975, after a hiatus of four years, *China 3* was launched. It was apparent that the launch vehicle was a potential ICBM booster from its reported weight of 3.5 metric tons, and the Chinese government frankly admitted that the satellite had a military purpose. Hsinhua said that *China 3* was part of China's drive to "prepare against war," the Chinese euphemism for defense against the Soviet Union's military presence to the north, and indeed the satellite transmitted data back to earth on frequencies suitable for long-range military communications. *China 3* remained in orbit for less than two months: it was brought down on September 14 and burned up on reentry over the Pacific.

On November 26, 1975, less than three months after *China 3* plunged back to earth, *China 4* was launched into orbit. About the size of *China 3, China 4* flew at altitudes of 173 to 483 kilometers, low enough for detailed photo reconnaissance. Six days after its launch *China 4* jettisoned a small capsule that fell back to earth; its 63-degree orbit prolonged the satellite's stay over China and may have been chosen to facilitate the usual Chinese method of retrieving satellite film by parachuting it to the ground. (In contrast, the U.S. recovers film capsules from its reconnaissance satellites by plucking them from mid-air with military aircraft equipped with devices that snare the capsules' parachutes.) In orbit only one month, *China 4* reentered the atmosphere on December 29.

China 5, another 3.5-tonner, was sent up only 13 days before its predecessor reentered the atmosphere. It did not jettison a film capsule and probably carried TV cameras that transmitted their images back to earth.

The launch of 250-kilogram *China 6* on August 30, 1976 seemed something of an anticlimax after its three larger predecessors. This satellite was to all appearances a scientific payload much like *China 2*.

The relatively unimpressive *China 6* was followed on December 7, 1976 by a satellite with sobering implications for the future of China's space effort. *China 7*'s weight of 3.6 tons and its orbit of 60 degrees indicated that a capsule would likely be jettisoned for recovery from the spacecraft. But the great weight of the capsule came as a surprise—about two and a half tons—more than half the total weight of the satellite and strong evidence that China might be planning manned space missions in the near future.

China 8 followed on January 6, 1978, weighing an estimated three to five tons. It also sent a large capsule back to earth.



The Next Step: Manned Satellites

One of the leaders of China's space effort, Jen Hsi-min, told *Aviation Week* in mid-1979 that China had made "preparations for launching manned spacecraft," and that indeed China did desire to build space stations in orbit, modeled after the U.S. *Skylab*. That revelation aroused intense curiosity in the West. How serious were the Chinese about their manned space program? What kind of training did they plan for their crews? The Chinese revealed less than a year later that several astronaut candidates were undergoing training at an unidentified "space facility" along with "future astronaut instructors." Obviously, the Chinese had a long-term program in mind.

The aerospace activities of the Chinese are likely to advance rapidly as they combine their achievements with the technology of Western space programs.

Chinese training techniques reportedly include centrifuge tests to duplicate the severe forces of large accelerations, zero-gravity training using aircraft that fly up-and-down patterns, rides in a swinging gondola to simulate a wildly tumbling capsule, vibration tests in which the subject is secured to a chair and then shaken violently to simulate launch conditions, impact training in which trainees are strapped to padded chairs and subjected to simulated hard landings (Chinese reentry vehicles, like the Soviet Union's, touch down on dry land, and Russian experience has shown those landings can be violent), and navigation training (the Chinese place strong emphasis on "steering by the stars").

The Chinese reportedly are hard at work on prosaic aspects of manned space missions such as food and have devised a "moon cake," able to be eaten without scattering crumbs about the cabin. These seemingly trivial details can become troublesome under zero-gravity conditions: there is always the nagging chance that a vagrant crumb or bead of beverage (which Soviet cosmonauts found to have a distressing tendency to become laden with potentially infectious microbes) will find its way into electrical equipment.



hina Probes Abroad

In 1979, a group of visiting experts on space technology from the United States toured more than a dozen aerospace-related installations in China, including:

☐ A factory that assembles China's new CSS-X-4, an ICBM with a range of more than 9,000 kilometers and capable of delivering a nuclear warhead of 5 to 50 megatons.

☐ A rocket facility near Beijing used to fire liquid hydrogen-oxygen rocket motors, such as those intended for the FB-1, which was used to launch *China 3* through *China 8*. The engines were small, with nozzles only about 15 centimeters across. The Chinese never made it clear whether testing was aimed at refining hardware or fabricating parts for actual missions in space.

☐ A satellite control center at Xi'an roughly equivalent to the U.S. Air Force satellite control facility in Sunnyvale, Calif.

☐ The Tung Fang Scientific Instrument Plant in Beijing, where the visitors studied a small spacecraft model. About a meter in diameter and solar-powered, it was designed to remain in orbit for years.

☐ The Institute of Technical Physics in Shanghai with a "most advanced" program in earth resources technology, including research on infrared sensing devices that could serve military as well as civilian ends. Infrared detectors are used in U.S. and Soviet satellites to watch for the telltale heat emissions of ICBM launches, and the Chinese probably have the same use in mind.

Until recently the Chinese have designed and built virtually all their own space hardware and programs according to the late Chairman Mao's dictum that "we should depend on our own resources." Although these achievements are impressive, because of their late start in space, the Chinese have had to confront numerous problems long ago solved by Western and Soviet aerospace engineers. For example, Chinese equipment generally weighs considerably more than similar American and Russian devices. The Chinese also have much ground to cover in developing remote sensing equipment and have expressed considerable interest in buying a Landsat receiving station.

Under an informal agreement reached in 1978, the U.S. government and private aerospace firms will assist the Chinese in expanding their satellite broadcast capability. The U.S. space shuttle will probably be used to send up Chinese communications satellites, and China has expressed interest in acquiring a powerful two-channel broadcasting system from General Electric for its educational television network.

Meanwhile, the West German firm of Messerschmitt-Boelkow-Blohm is discussing a joint Chinese-German program for putting direct-transmission communications satellites in orbit. Thus, the aerospace activities of the Chinese are likely to advance rapidly as they combine their achievements with the technology of Western space programs. The Chinese are also capable of launching ICBMs, an advance that must be considered in assessing future prospects for world peace.

David Ritchie is a science writer and a graduate student in biology at the University of Massachusetts. He is the author of *The Ring of Fire* (Atheneum, 1981) and is currently writing *Spacewar*, to be published by Atheneum next year, from which this article is excerpted.

RESUME OF A PROSPECTIVE EMPLOYER

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A FEW HIGHLIGHTS FROM OUR 100 YEARS OF EXPERIENCE:

1880. Fred Taylor, using something called a cable drill, reaches the hard-won depth of 560 feet. Rock gives way to oil.

1959. The first of the modern hydrocracking processes, developed by Socal researchers, is commercialized, providing an economic response to fuel oil demands for the next 20 years.

1967. Socal researchers come up with a naphtha reforming process called Rheniforming, which increases refinery capacity to produce unleaded gasolines.

1978. With construction and installation directed by Socal engineers, the largest offshore rig in history is settled in the turbulent North Atlantic. The central platform is 1½ times the height of the Great Pyramid, and the largest man-made object ever moved.

1982. We don't know what the breakthroughs will be this year, but we've committed $2.8 billion to making sure there are some.

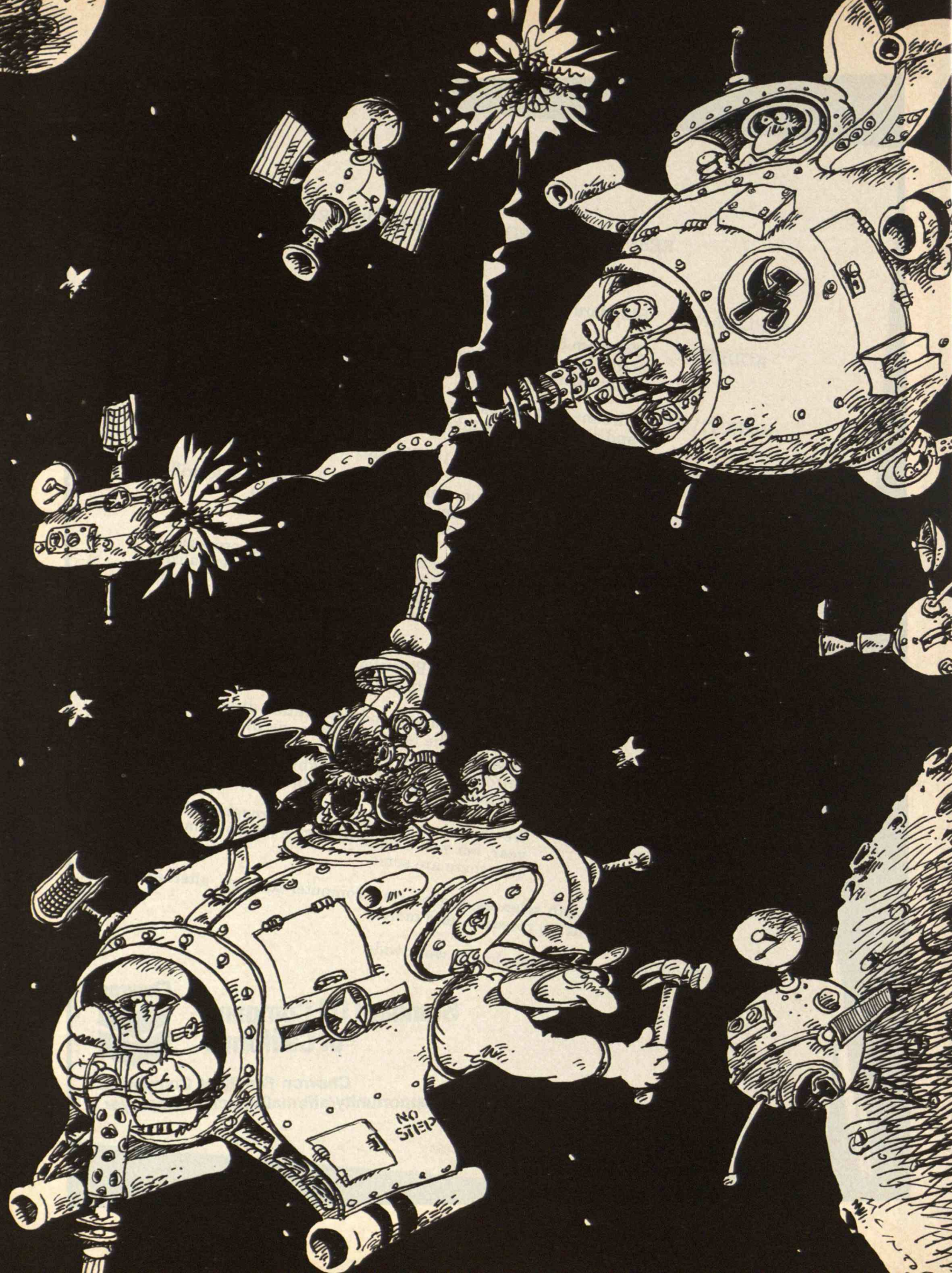
ACTIVITIES: Earth sciences, engineering, computer sciences, alternative energy research, and more.

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NO
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The Ultimate Battleground: Weapons in Space

Increasingly widespread notions of orbiting death rays and celestial Waterloos are mainly the stuff of speculation, for wars in space are more picturesque than practical.

by Gerald Steinberg

THE space shuttle, two recent tests of the Soviet antisatellite system, and the burgeoning budget for the development of space-based laser weapons have led to increased talk of the prospects for space warfare. Often punctuated by illusions of extravagant spacecraft and weapons paraphernalia, these discussions usually take place without historical, strategic, and technical perspectives. The strategic value of space weapons is generally overstated and the risks and technological obstacles to their deployment trivialized.

Early Antisatellite Programs

The first U.S. antisatellite program, designated SAINT for "satellite interceptor," was funded in 1957 in response to fears that the Soviet Union would develop orbital bombs, satellites, and antisatellites to "seize the high ground of space." Advocates of SAINT proposed that the Soviet Union would be able to occupy "strategic areas in space vital to future scientific, military, and commercial programs" and thus deny the United States access.

As originally conceived, the orbiting SAINT interceptor would maneuver to a target, inspect it with sensors, and if ground observers directed, blow up close enough to the target to alter its orbit, incapacitate its instruments, disrupt its power and communications systems, or destroy it entirely. However, the SAINT mission was actually limited to orbital inspection, by far the most difficult task—satellites are fragile and unprotected instruments, and their destruction is very simple once they are located. Other potential antisatellite systems were developed and tested by the air force using B-47 and F-4 aircraft as launch platforms, and the army proposed that the Nike-Zeus anti-ballistic-missile system be adapted to perform an antisatellite mission.

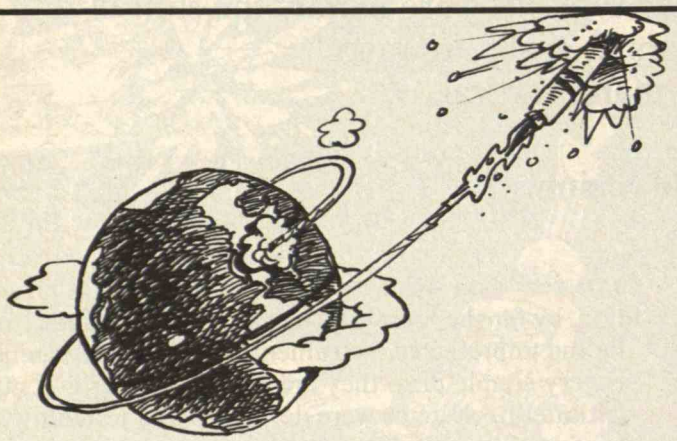
In the early 1960s, U.S. reconnaissance satellites revealed that the Soviets' deployment of intercontinental ballistic missiles (ICBMs) was far less than claimed. The Soviets condemned these U.S. space reconnaissance programs: Prime Minister Nikita Khrushchev declared that "a spy is a spy, no matter at what height it flies," and claimed that the Soviets would "shoot down" or disrupt the operation of "espionage satellites." Although this would have required an antisatellite system, it was an entirely credible threat in view of the variety of capabilities in space the Soviets had by then demonstrated. For example, in August 1962, two Soviet spacecraft were launched into similar orbits that brought them to within three miles of each other, leading analysts to warn that the Soviets were rapidly approaching an antisatellite capability. Meanwhile, the Soviet Union introduced a resolution in the United Nations that would have justified the use of antisatellites against espionage satellites.

Why Orbital Weapons Bombed

AFTER *Sputnik* was launched, space was considered a likely place to park nuclear weapons. Noting that an orbital warhead could reenter the earth's atmosphere and hit a target in half the time needed by an ICBM, air force officers testified before Congress that "in Major Titov's orbital flight of last August (1961), his *Vostok* spaceship passed within 150 miles of this building." This image of a hammer-and-sickle-inscribed "sword of Damocles" hovering over the United States was enough to prompt development of orbital antisatellites such as SAINT.

Yet space is the single medium not used as a base for nuclear weapons, a fact cited by some as a major arms-control success. Early evidence of this lack of enthusiasm for orbital weaponry appeared in 1962, when the deputy secretary of defense announced that the United States would not be the first to put bombs in outer space. In October 1963 after some negotiation, the United States and Soviet Union agreed to a U.N. resolution pledging not to station weapons of mass destruction in space, even though neither side could verify compliance. Four years later, these pledges were codified in the Outer Space Treaty. The fundamental reason for the agreement was not merely goodwill but the realization that space-based nuclear weapons would create more problems than they would solve.

First, orbiting nuclear weapons could hit only targets directly in their flight path—a satellite could take hours or even days to line up with and then hit Moscow or New York. Second, orbital weapons would be far less accurate than ICBMs and bombers: controlling reentry of satellites is difficult and inaccuracies of many miles are common.



Some U.S. government advisors opposed to SAINT claimed that deployment of U.S. antisatellites would stimulate the Soviet Union to develop or strengthen its military antisatellite capabilities. George Kistiakowsky, President Eisenhower's science advisor, pointed out that any Soviet antisatellite system would probably be used to interfere with U.S. reconnaissance satellites. He reasoned that since the United States relied far more than the Soviet Union on such satellites, we would suffer the greater loss if antisatellite development were stimulated.

On the strength of such criticisms, the Kennedy adminstration in 1962 reviewed U.S. programs that appeared to be contributing to an arms race in space, and in December of that year Secretary of Defense Robert S. McNamara cancelled the SAINT program prior to its first scheduled tests. Six months later Soviet policy also changed: support for the section on "espionage satellites" of the U.N. resolution on space was quietly withdrawn, the Soviet Union began its own reconnaissance satellite program, threats to "shoot down" U.S. satellites gradually ceased, and evidence of Soviet efforts to develop an antisatellite capability diminished. The United States and the Soviet Union separately declared shortly thereafter that each would forego systems such as orbiting bombs and warheads, and the "age of space combat" was at least postponed.

The pace of antisatellite activity varied from 1963 to 1977. Two ground-based antisatellite systems armed with nuclear warheads were deployed by the United States in the Pacific in 1963. These systems were not based on placing interceptors into orbit. They were instead designed to launch antisatellite devices to intercept enemy satellites as they passed over the launch points at altitudes of between 100 and 400 miles. Depending on its orbit, a potential target could come within range as often as every 90 minutes or as infrequently as once in 18 days (for a satellite in polar orbit). Obviously, this system had limited potential for a timely response. A further drawback was that these antisatellite missiles were armed with nuclear warheads and could have damaged U.S. satellites orbiting in the region of the target. After 1963, the testing or use of these systems would have violated the Limited Test Ban Treaty, and the systems were finally decommissioned in 1975.

During the mid-1960s, first the United States and then the Soviet Union developed the capability to maneuver and rendezvous in space, essential to orbital antisatellite systems. In 1965, following the civilian Gemini flights, the air force proposed a number of ways to exploit their techniques in antisatellite systems. These programs, including the Blue Gemini, the Manned Orbital Development System, and the Manned Orbiting Laboratory, were all cancelled by Defense Secretary McNamara for political, econom-

Finally and probably most important, orbital weapons would be difficult to operate. Unlike bombers and missiles directly launched by pilots and ground officers, satellites carrying nuclear weapons would be controlled remotely. They would also be subject to various forms of interference, making them unreliable in a crisis. In addition, satellites are subject to technical failures that lead to unscheduled and uncontrollable reentry. Problems enough were caused when the U.S. *Skylab* landed in a remote section of Australia and the Soviet *Cosmos 954* deposited its radioactive debris in Canada; imagine the havoc had such satellites been armed with nuclear weapons.

Despite the view that orbital weapons were more costly and less effective than other forms of delivery systems, reaching agreement on their restraint was not simple. As Raymond Garthoff, who served in a variety of arms-control positions in the State Department, notes, President John Kennedy pursued this ban only after receiving "a unanimous recommendation of all interested agencies and departments *against* such a ban." The military wanted to keep its options open, while other groups, questioning whether such an agreement could be verified, sought to keep space arms control within the larger package of "general and complete disarmament." It was only through the forceful action of the president and his advisors that the agreement was reached.

The lessons for arms control are clear. While a new weapons system may be neither effective nor useful, mutual restraint is not automatic. Only persistent efforts to reach successful agreements can counteract bureaucratic inertia and parochial interests.—*G.S.* □

ic, and technical reasons.

In contrast, the Soviet Union continued to pursue development of its antisatellite capability in three distinct series of tests. The first series, beginning in 1968, consisted of seven trials in which a "target" satellite was placed in orbit, followed the next day by a "hunter-killer" satellite launched from the same site into a highly elliptical orbit with a similar inclination. After the second (interceptor) satellite completed one or two orbits, its path was altered to allow the two spacecraft to intersect. The antisatellite was then moved into another orbit and detonated, scattering fragments in all directions. U.S. analysts credited the Soviets with "possible successes" in five of these seven tests based on the fact that the two spacecraft apparently closed to within one kilometer. (However, there is some question whether a detonation at this distance would ensure damage to the satellite. A "miss" distance of 0.1 kilometer is probably a better requirement.) In the second series of tests between 1976 and 1978, the Soviets launched eight pairs of spacecraft, and a third series included three tests—a failure in April 1980 and two "probably" successful tests in February and March 1981.

The United States responded to the initial antisatellite tests in 1968 by funding and expediting programs to "harden" and protect U.S. space systems against an antisatellite attack, including radiation from nuclear detonations. A test program to develop "survivable" satellites was initiated, as was research on power systems to replace highly vulnerable solar cells. The role of the space shuttle as a system to facilitate the rapid replacement of damaged satellites was emphasized.

In 1977, Secretary of Defense Harold Brown declared that the Soviets had developed an antisatellite capability. He announced that the United States would shift from its defensive posture to deterrence and develop a system similar to the Soviet antisatellite program: the "miniature homing vehicle" (MHV). Thus, after 20 years of successfully skirting an arms race in space, both the United States and the Soviet Union were aggressively at work on orbital antisatellites.

Launched from either an aircraft or the ground, the MHV destroys its target by ramming into it. The effectiveness of the MHV is difficult to judge, but most experts agree that in the absence of countermeasures, this system will probably be quite reliable against targets at modest elevations—those with perigees (points of closest approach to the earth) of less than 1,000 kilometers. More energy would be required to reach targets in significantly higher orbits, and air-launched vehicles are not likely to have sufficient thrust. In addition, interception of targets at higher altitudes would require greater accuracy, since small angular deviations become large misses at great distances.

Some reliable estimates place the cost of the air-launched version of the MHV, currently under development, at approximately $1 million per booster, with the simplest ground-launched system expected to cost $2 to $3 million per unit. Advanced MHV systems for reaching targets higher than 1,000 kilometers will probably require more fuel for maneuvering and a variety of auxiliary systems, increasing both their weight and cost.

Beyond the MHV

Given the limited capabilities of MHV, what are the likely next stages in the development of antisatellite

capabilities? The space shuttle and directed-energy (particle-beam and laser) systems are frequently cited as alternatives, but an examination of their technical properties reveals several weaknesses.

The space shuttle is capable of intercepting and retrieving defective U.S. satellites. But Soviet analysts and some Western journalists have argued that this function can be extended to an antisatellite role in which "enemy" satellites would be intercepted, damaged, or even captured. However, upon close examination of the shuttle's capabilities, this possibility is very small, perhaps even nonexistent. In the first place, the shuttle is confined by its design to orbits below 600 miles (960 kilometers); many satellites, including potential targets, are in higher orbits. Second, the shuttle has limited maneuverability; the interception of many satellites in low orbits would be costly if not impossible because of the large amount of fuel required to shift the shuttle into position. Finally, any shuttle-based antisatellite operation involving retrieval could be readily countered by "booby-trapping" potential targets. For example, the Soviets could simply rig their less costly satellites to explode under contact with a foreign object.

However, the shuttle may be capable of rapidly inserting an MHV into orbit for interception of a target satellite. Thus, the shuttle gives the United States an orbital antisatellite capability comparable to that apparently under development by the Soviet Union.

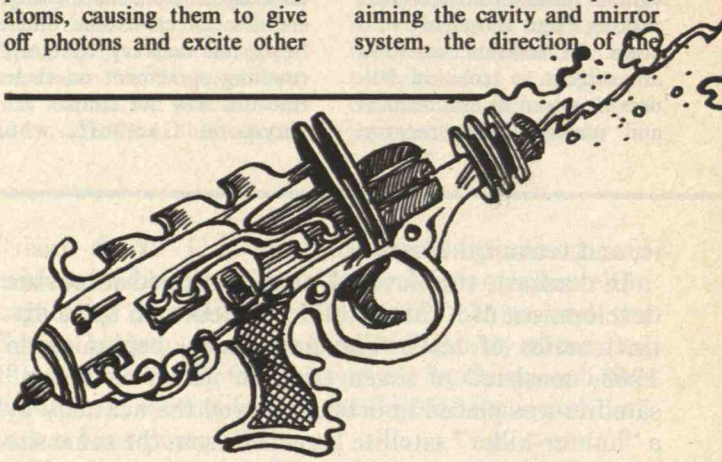
Laser and Particle Beams in Space

The shuttle is frequently portrayed as a potential platform for the development, testing, and deployment of exotic antisatellite weapons based on directed-energy systems such as lasers or particle beams. These devices are popularly considered a means of destroying enemy ballistic missiles before they reach their targets, but they can also cause target satellites to crack, melt, or vaporize.

There have been persistent reports of Soviet efforts in these areas, and the U.S. Department of Defense has allocated over $1 billion to directed-energy research and development programs. Since particle-beam and laser-beam antisatellites could be used repeatedly, they would be far superior to devices such as the MHV in which each antisatellite can destroy only a single target. In addition, while conventional antisatellites must come very close to or even intersect their targets, laser-based antisatellites could cause damage at large distances.

How Directed-Energy Systems Work

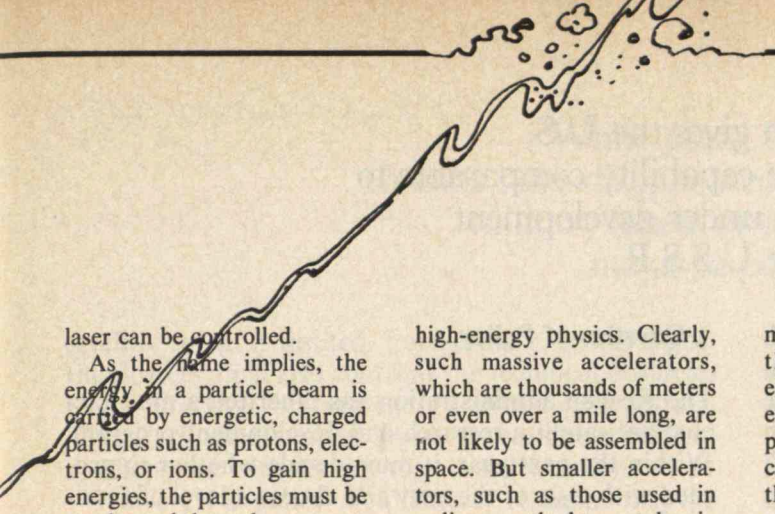
DAMAGE from laser weapons is caused by the impact of a highly focused monochromatic beam of light that carries a great deal of energy. The atoms inside the laser cavity are excited by an external power source and emit photons that hit other nearby atoms, causing them to give off photons and excite other atoms. The result of this multiplying effect is a steady stream of photons locked in phase and of equivalent energy—a laser beam. The laser cavity is bounded at each end by mirrors, one of which is partially transparent and allows the beam to escape. By aiming the cavity and mirror system, the direction of the



While the physical principles behind laser weapons systems are straightforward, the technological requirements and the obstacles to developing operational systems are controversial. Proponents of a crash program to develop the systems argue that the technical obstacles can be readily overcome, and that, in fact, the Soviet Union has or is close to solving them. Critics, on the other hand, argue that these obstacles are formidable and while perhaps not insurmountable, would increase the cost of the system beyond a reasonable level. To complicate this debate, much of the relevant information is classified and selectively leaked by both sides.

In theory, directed-energy antisatellite systems could be based either on the ground or in space. Ground-based systems are easier to build but are limited by weather and location; line-of-sight contact between satellite and ground site would be required, for example. Furthermore, the atmosphere between the ground and the target would significantly reduce the amount of energy reaching the target. And a relatively small investment in shielding and insulating satellites could probably protect even sensors, electronics, and other highly sensitive systems from such ground-based lasers or particle beams.

By contrast, space-based directed-energy systems could deliver substantially larger amounts of energy to many more targets. A laser or particle-beam antisat-



laser can be controlled.

As the name implies, the energy in a particle beam is carried by energetic, charged particles such as protons, electrons, or ions. To gain high energies, the particles must be accelerated through a magnetic field such as those generated by the large linear and circular accelerators used in high-energy physics. Clearly, such massive accelerators, which are thousands of meters or even over a mile long, are not likely to be assembled in space. But smaller accelerators, such as those used in ordinary cathode-ray tubes in televisions, do not provide sufficient energy. A space-based particle-beam accelerator must lie somewhere between the two extremes—large enough to generate sufficient energy but small enough to be placed in orbit. Energy beams capable of depositing a few thousand joules per fraction of a second per square centimeter on a target are required. (By comparison, the noonday sun produces about one-tenth of a joule per second per square centimeter.) Such energies would be sufficient to damage the target through melting, vaporization, or the impact of a mechanical impulse. Damage to more sensitive systems (sensors, electronics, power supply, or thermal balance) could occur at lower energies.—*G.S.* □

ellite above 40,000 kilometers would have a very wide field of view, and three such satellites could maintain all potential targets in view.

But the situation is complicated by the fact that the amount of energy delivered to a target decreases with the square of the distance. And since most targets for such a three-satellite system would be far away, a great deal of energy would be required to do serious damage. Moreover, very large satellites must accommodate massive accelerators for particle-beam generators and large mirrors for laser weapons.

A beam of charged particles in space is affected by "self-repulsion"—the interaction of similarly charged particles—which causes the beam to spread. Such beams are also affected in space by the earth's magnetic field, which fluctuates rapidly in intensity and direction. Together these two effects could be large enough to eliminate the possibility of damage to a target by a particle beam generated at a distance of 1,000 kilometers or more. Substitution of a beam of neutral particles created by stripping excess electrons from hydrogen ions would eliminate some of these frustrations, but this option has a number of technical problems. An orbiting accelerator that could produce high-energy hydrogen ions and strip them of their electrons would have to be massive, and the resulting neutral hydrogen beams could easily be countered with a variety of protective measures.

Laser antisatellite systems involve lesser technical obstacles, and a number of demonstration and development programs are currently underway. In 1978, the navy demonstrated the potential of laser weapons systems by shooting down a specially prepared missile at a distance of less than one kilometer. The air force is testing an airborne laser laboratory (ALL), but this system failed to shoot down a target missile in its first two attempts.

A similar but considerably more powerful system could be placed in earth orbit by the space shuttle. If a current laser weapon deposited just enough energy to damage its target at a distance of 1 kilometer, the power of the system would have to be increased by a factor of 1 million to damage targets at a range of 1,000 kilometers. Furthermore, if this system is to have significant advantages over the conventional MHV antisatellites, it must be capable of destroying multiple targets in a short period of time. The entire system weighing many tons would have to be rapidly rotated into a series of precise positions. This problem alone may make the entire program infeasible. Finally, even if a laser antisatellite were successfully deployed, the mirror and other vital components could be readily damaged by conventional antisatellites such as the current Soviet system or the U.S. MHV.

As a result, most analysts, including many in the U.S. defense community, have determined that deployment of an operational directed-energy antisatellite would be a waste of resources. In a study of space-based missile defense, the Defense Science Board concluded that "it is too soon to attempt to accelerate space-based laser development toward integrated space demonstration for any mission," including antisatellites. In particular, it cited the "technical uncertainties" in the development of laser power and optics. While relatively unsophisticated systems may be technically feasible for both the United States and the Soviet Union, the costs of deploying effective systems make them impractical for the foreseeable future.

Despite these stumbling blocks, the United States and (according to some reports) the Soviet Union are spending large sums on research and development in these areas. Senator Wallop of Wyoming, a major supporter, sought to add $250 million to the defense budget for the development of a laser weapons system. This was reduced to $50 million, but the supporters of a crash program have not given up, citing

The shuttle gives the U.S. an orbital antisatellite capability comparable to that apparently under development by the U.S.S.R.

the possibility that a technological breakthrough could give the Soviets major strategic and political advantages. According to Wallop, the Soviets will be testing an orbital laser weapon by mid-decade. Such competition is reminiscent of the "nuclear airplane" project of the late 1950s and early 1960s, on which billions of dollars were spent despite widespread belief that such a system would never get off the ground.

Increasing First-Strike Incentives

The role perceived for U.S. antisatellites has changed significantly since the SAINT program of the early 1960s. While plans for orbital bombs have disappeared, protection of other military assets in space is now of major importance.

Over the past two decades satellites have assumed major roles in U.S. military support systems for photographic and electronic reconnaissance, command, control, and communications; early warning; and navigation. For example, the satellite-based navigation system NAVSTAR is designed to be used by ground troops and tanks as well as ballistic missiles launched from Trident submarines. By interfering with NAVSTAR satellites, the Soviets could seriously impair U.S. military capabilities.

The availability of effective antisatellites would also significantly affect arms-control negotiations. Surveillance satellites monitor compliance with arms-control policy, and a threat to them is a threat to any such agreements. In addition, if a nuclear exchange appeared imminent, each side would probably seek to impair the other's satellite-based systems, which could be interpreted as a prelude to a nuclear first-strike. Such an attack might critically impair the ability of the other side to coordinate its response with conventional as well as nuclear weapons.

Just as the development of railroads increased the ability and incentives for both sides to begin World War I by allowing rapid mobilization of troops, the development of antisatellites would increase incentives for rapid action in times of international tension. The incentives for one nation to strike first, before its satellite support systems were disrupted, would be great. A second nation whose satellite systems had been destroyed would also be motivated to act before its adversary could capitalize on this advantage. The existence of antisatellite systems could also lead to the development of anti-antisatellites, further contributing to an expensive arms race in space.

A Question of Policy

The Reagan administration has inherited a multifaceted antisatellite research and development program. Within the next year, it must decide whether to proceed with tests of the MHV and choose a level of funding for research programs in directed-energy systems. Advocates of a relatively unrestricted U.S. program argue that efforts must be expanded to counter the perceived Soviet antisatellite system. Without such an effort, advocates say, the Soviets' antisatellite program will be capable of disrupting U.S. military satellites without risking a similar U.S. response, giving them a major advantage in either a conventional or nuclear conflict. A U.S. antisatellite capability could deter the Soviets from such action, and if deterrence failed, would allow the United States to impair the Soviet military satellite system in kind.

Advocates also argue that with our technological superiority in this area, we could easily outdistance the Soviets. They do not see the technical obstacles as insurmountable; Senator Wallop claims that "actual physical pieces of the system exist. Only the money and the will to put them together is lacking." Current policy is consistent with this opinion, and there is support in Congress for increasing the allocations for antisatellite and directed-energy research and development programs.

Critics argue that the development of a U.S. antisatellite system will not, in itself, discourage the Soviet Union from using its system. They note that since the Soviets are less dependent on their space systems than the United States, they would have less to lose in a conflict in space. Some supporters of the U.S. antisatellite effort, including Seymour Zeiberg, former deputy undersecretary of defense for research and development, acknowledge the logic of this argument and advocate a more measured policy. Rather than deploying antisatellites, they propose to increase the survivability of U.S. military support satellites and earth-based alternatives.

Opponents also note the apparent limitations of the Soviet antisatellite system: it has been used only against targets in low orbits of the same inclination as the hunter-killer satellites. The interception of satellites in orbits of radically different inclinations at altitudes above 1,000 kilometers is beyond Soviet capability, and there is little evidence the system could be readily extended to perform such tasks. Since most U.S. military satellites are in either very low orbits or well above 1,000 kilometers, the current Soviet anti-

While plans for orbital bombs have disappeared, protection of other military assets in space is now of major importance.

satellite threat is limited. Furthermore, critics argue, the Soviets must also confront the technical obstacles to an effective directed-energy antisatellite system. Thus, U.S. efforts can be limited to basic research and development without risk to national security.

However, a policy of unilateral restraint may be politically costly. Any Soviet program unmatched by a comparable U.S. effort is generally subject to a "worst-case" analysis: the Soviets' technical capabilities are extended well beyond those supported by the available evidence. This happened in 1962 when the Soviets were attributed with having an antisatellite system after the dual launching. The testing of an ineffective directed-energy antisatellite system by either side would similarly lead to unnecessary threats to international stability.

Stratospheric Standoff

A third option is now advocated by some observers, including Richard Garwin of IBM and Harvard's Kennedy School of Government and Donald Hafner, former advisor to the U.S. SALT delegation: a treaty to limit the development and deployment of both U.S. and Soviet antisatellites. A model of such an arms-limitation agreement is provided by the 1972 Anti-Ballistic-Missile Treaty, in which the United States and the Soviet Union agreed to limit ABM deployment to two sites (later decreased to one) and placed very broad restraints on the development of new deployment modes.

Antisatellite development is now at a stage similar to that of ABM systems prior to the 1972 agreement: the Soviet Union has a very primitive and unreliable but formally operational antisatellite system, while the United States is in the process of developing the more sophisticated MHV. In the case of the ABM, high cost, technical unreliability, and domestic opposition contributed to the establishment of restraints. With the MHV antisatellite, these factors are less obvious.

Bilateral constraints were the subject of the antisatellite-limitation negotiations conducted sporadically between June 1978 and August 1979. However, the United States and the Soviet Union entered the negotiations with different capabilities and objectives, and various U.S. agencies could not agree on common goals. For example, the air force argued that prior development of a U.S. antisatellite system was necessary as a bargaining chip, while other agencies argued that further development would block any opportunity for limitations. And while the Soviets argued that the shuttle gives the United States an effective antisatellite capability, the U.S. stressed that the shuttle is not an antisatellite system.

Increasing tensions between the United States and the Soviet Union after the Soviet invasion of Afghanistan, and the general skepticism about arms control in the Reagan administration, are not conducive to arms-control negotiations in general and antisatellite-limitation talks in particular. Nevertheless, both nations would benefit from unobstructed use of satellite systems, and neither would benefit if the other succeeded in deploying a directed-energy antisatellite system.

Even in the absence of formal arms-control negotiations, tacit limitations are possible. Such an informal process led to a relaxed attitude about reconnaissance satellites and the generally low priority of antisatellite development in the 1960s. If such policies continued, the United States could postpone development of the antisatellite with little risk since current Soviet capability poses a very limited threat.

This risk could be further reduced by "hardening" present U.S. military satellites against possible attack and deploying redundant command, control, and communications systems in space, in the air, and on the ground. Such an approach would serve American interests even if the Soviets proceeded with their own program. The alternative is to sink billions of dollars into a project that is strategically, technically, and fiscally dubious.

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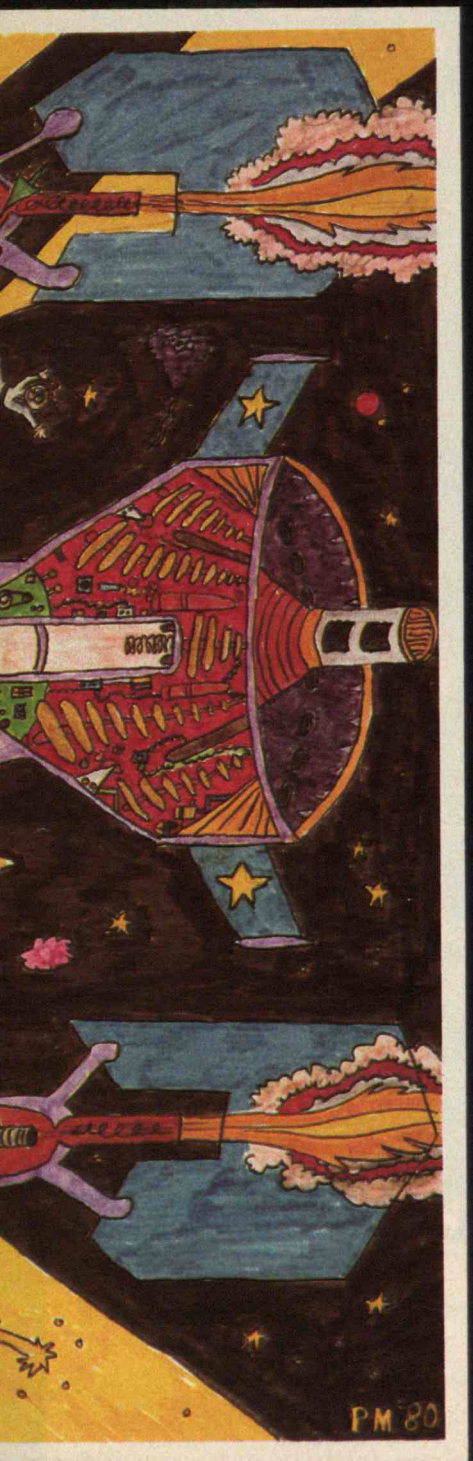
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Gerald Steinberg is a postdoctoral fellow in the Arms-Control Program at M.I.T.'s Center for International Studies. He did undergraduate work in physics at Berkeley and completed a master's degree in astrophysics at the University of California at San Diego before switching to international relations at Cornell, where he received his doctorate. Dr. Steinberg has served as a consultant to the Department of Energy and the congressional Office of Technology Assessment.

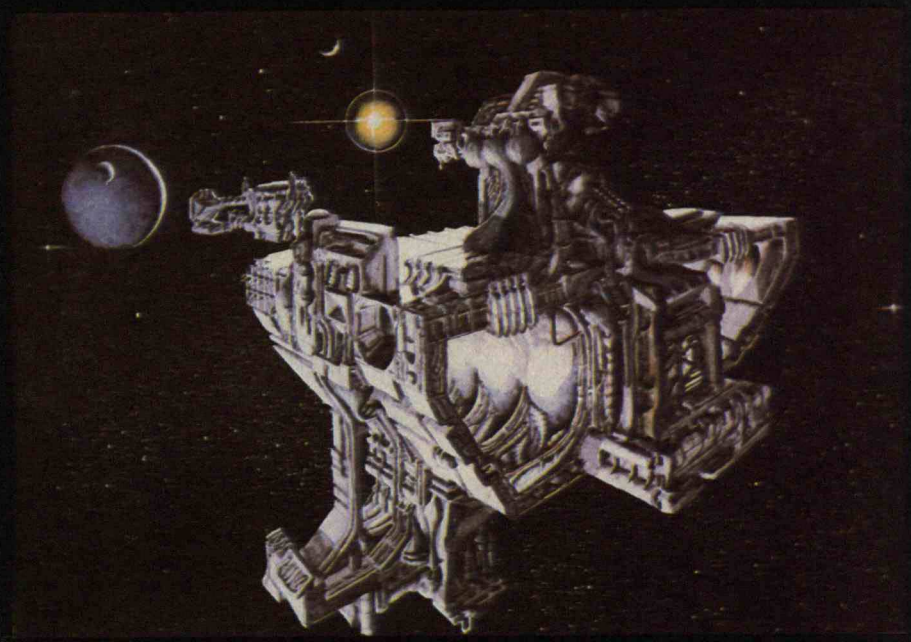
Below:
Space Station
by Pieter Mulder
16 years old
Netherlands

Right:
Spacecraft and Planets
by Stefan Riedl
18 years old
Austria





A Youthful Platform for Space



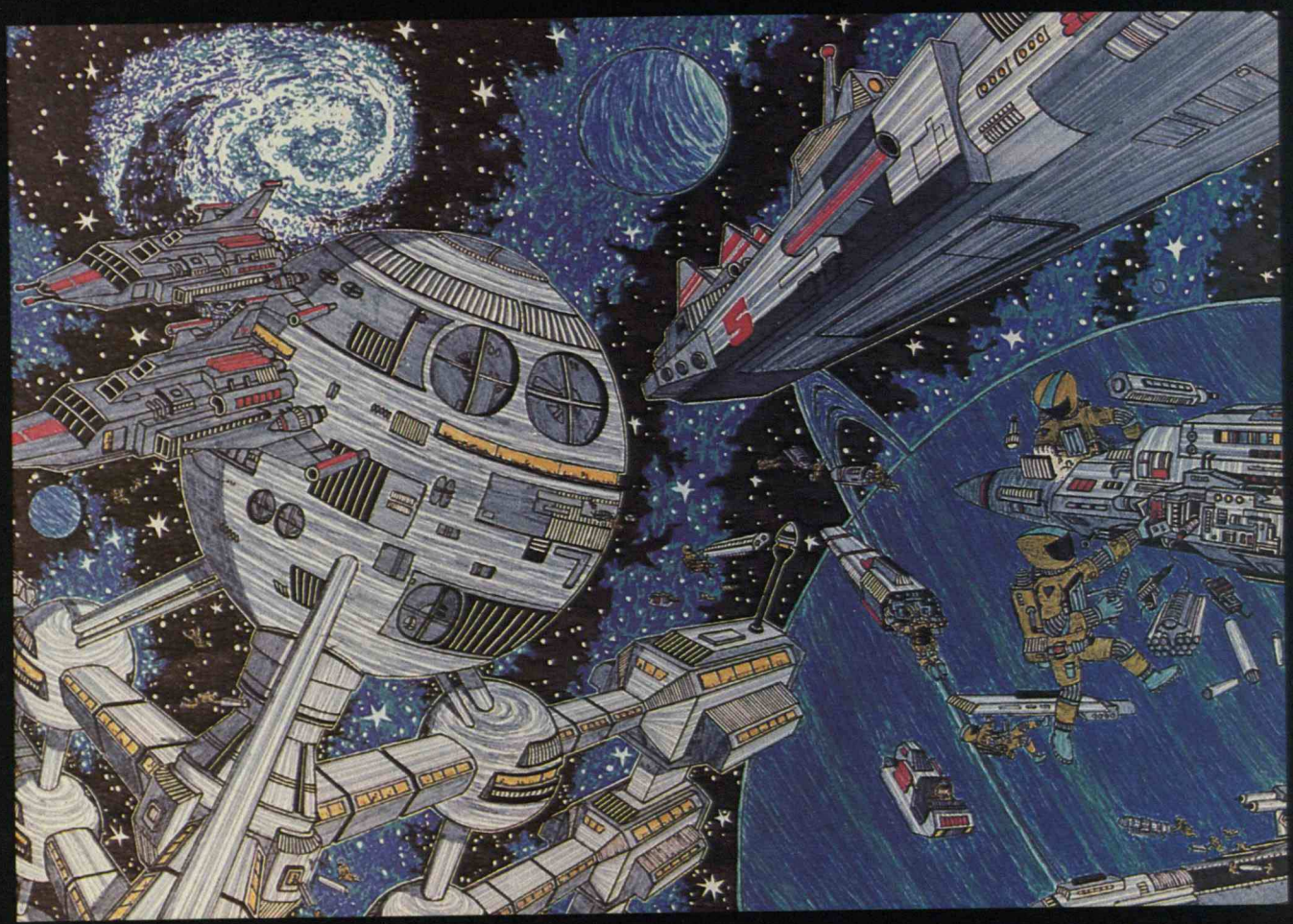
Today's plans for exploiting space stem from adult visions—not from those of children, the beneficiaries of our efforts. How do our progeny perceive this great challenge?

To find out, the European Space Agency recently ran an art contest called "Man and Space" among European youth. Results are particularly revealing. Even as world leaders increasingly emphasize the military potential of space, the children conjured scenes of bustling spaceports, serene flights over a mosaic earth, fantastic vessels in the depths of space—and an astronaut's tender adieu to a flower. The works of these gifted young artists hold a profound lesson for us all. (*Art courtesy of the European Space Agency, from Publication Sp-1024.*)—*L.A.P.*



Left:
Maestro
by Linda Soto
14 years old
Switzerland

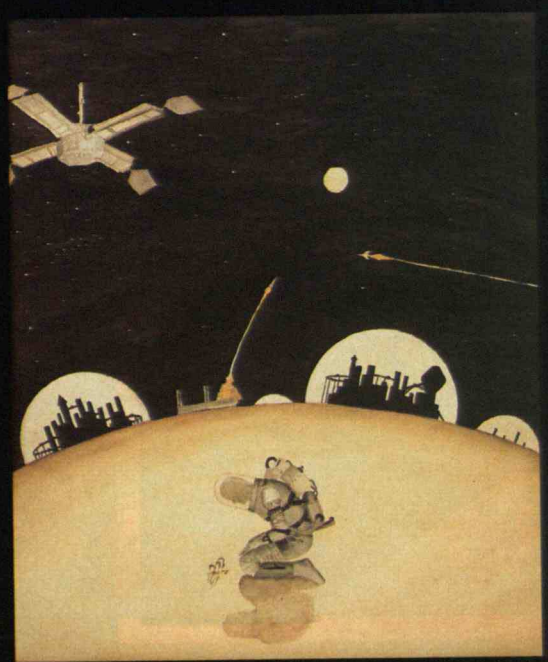
Below:
Research on Uranus
by Hendrik Wilhelm van Walraven
15 years old
Netherlands



Right:
L'Homme dans l'Espace
by Judicael Géhin
7 years old
France

Far Right:
When the Last Flower Dies
by Bjorn Bergenholtz
18 years old
Sweden



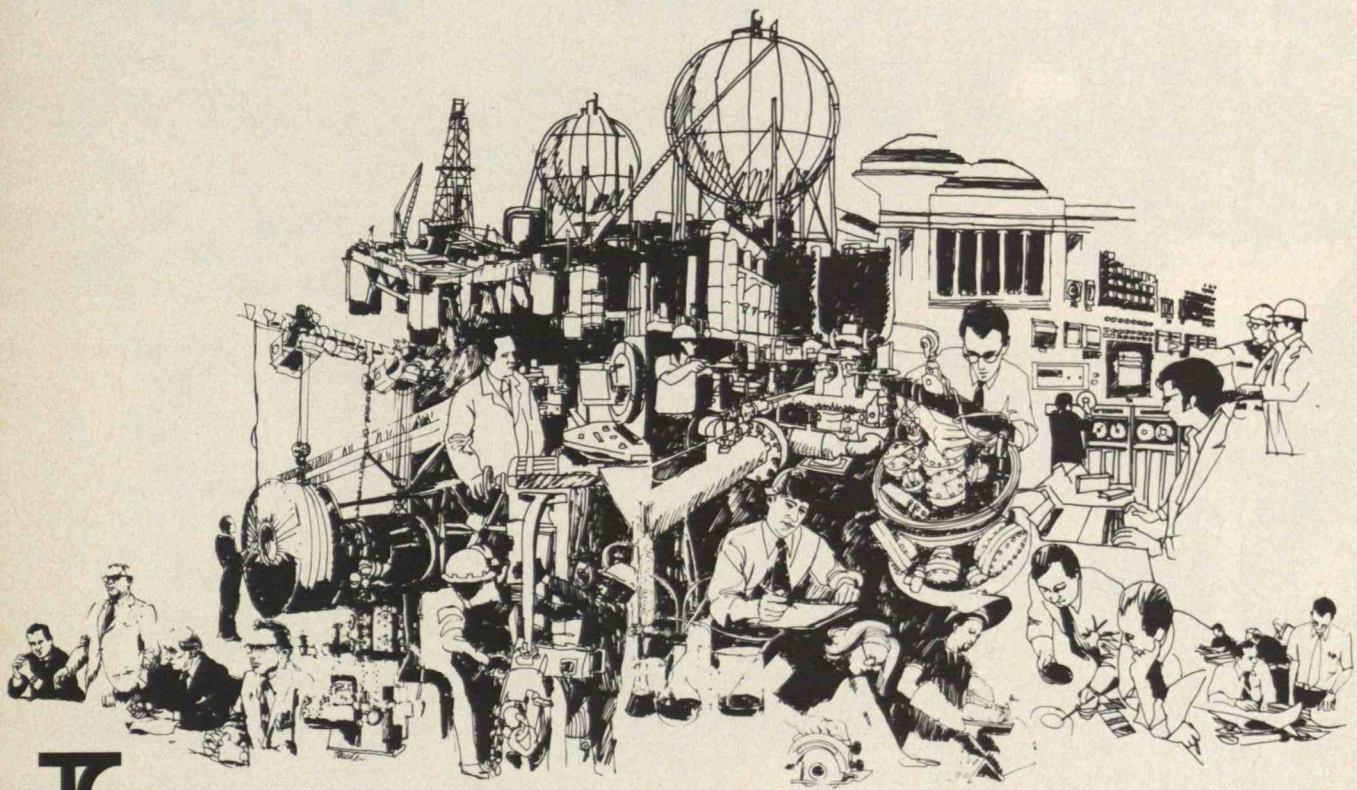


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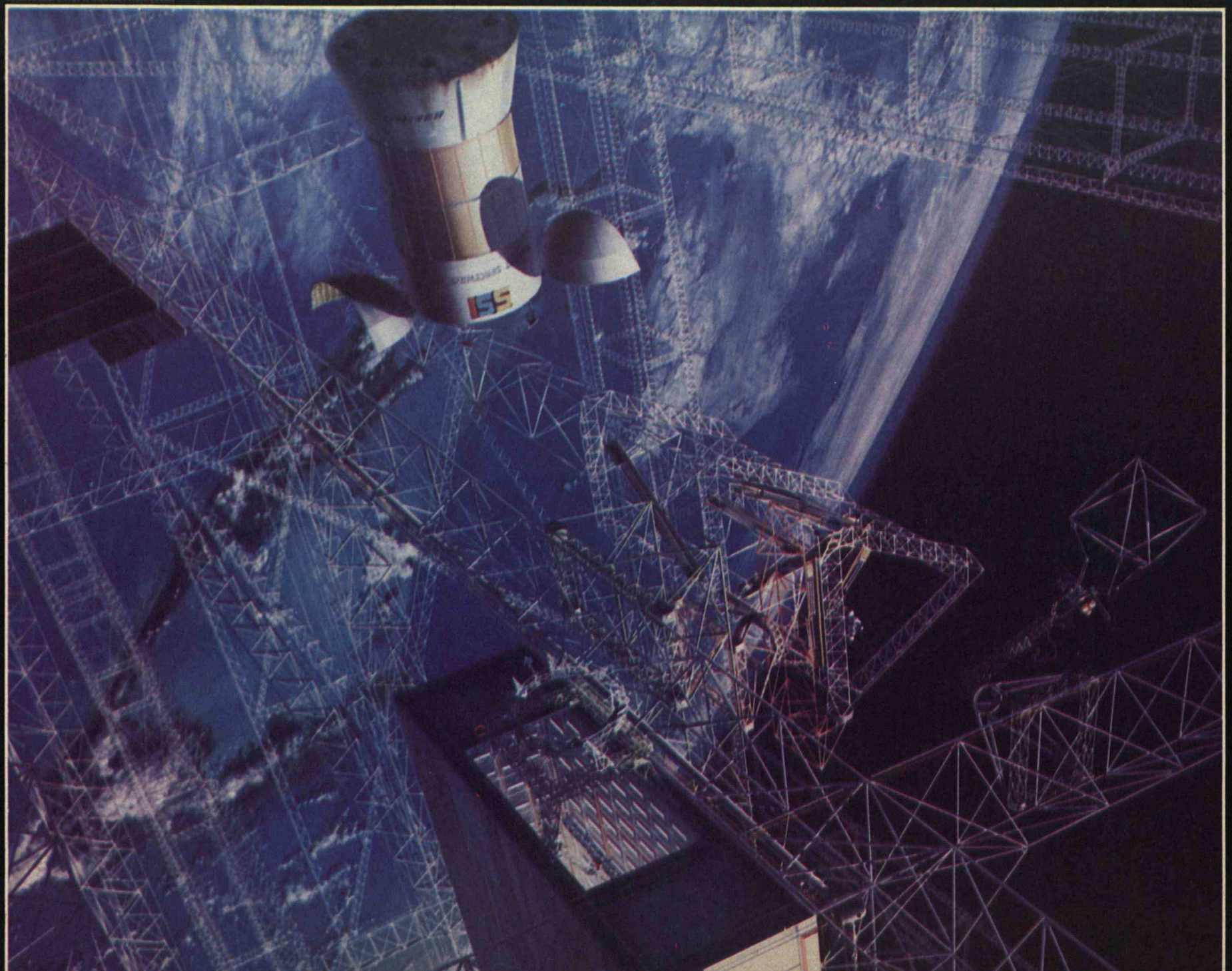


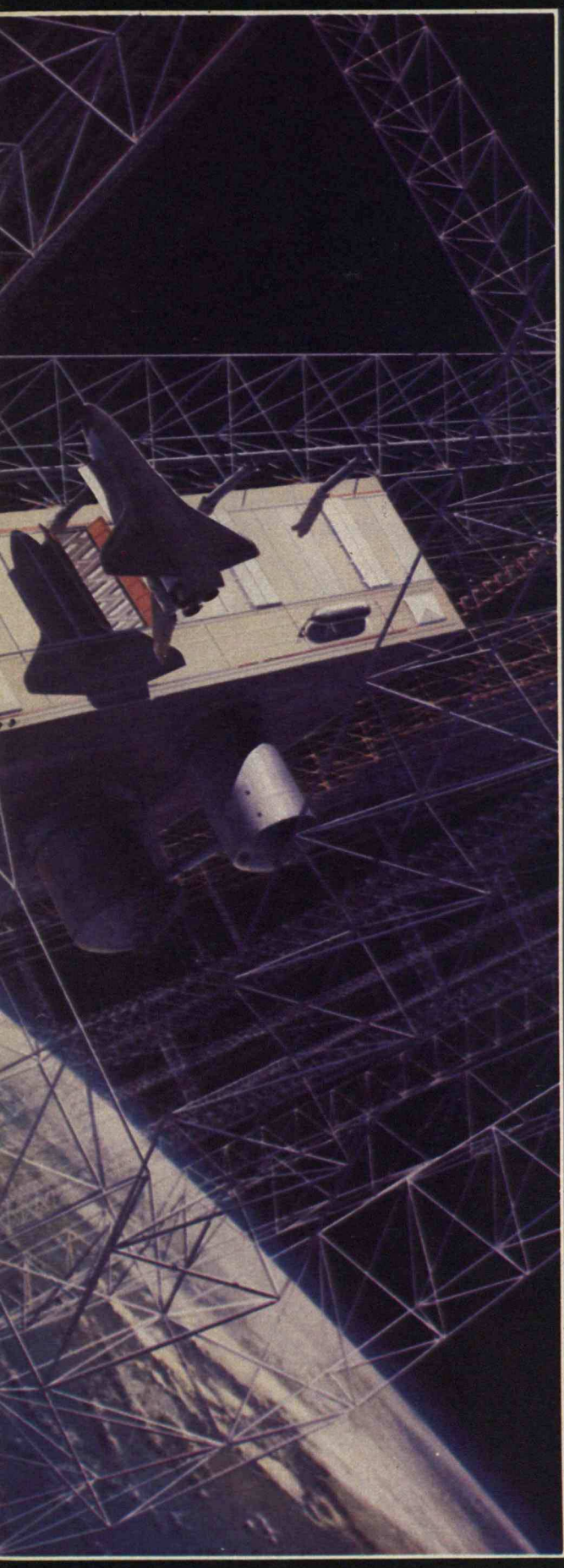
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Space Technology: Where Will Fiction Meet Reality?

by Giuseppe Colombo

The line between science and fiction is as much a state of mind as of technology. The human race may soon need to learn how that line can be moved.

"There is no one among you who has not gazed long and carefully on the moon, or at least who has not heard of those that have. Do not be surprised if I have to say a few words tonight regarding the queen of the starry sky. For to us is perhaps reserved the glory to be the Columbuses of another new world."

So said President Barbicane to the members of the Baltimore Gun Club in October 1865 in Jules Verne's novel *From the Earth to the Moon.* Barbicane continued by reporting his calculations of how to send a ball to the moon: any projectile properly directed and given an initial velocity of 12,000 yards per second must surely reach it. "This grand experiment, gentlemen," he concluded, "I have the honor of proposing to you for a trial!"

At its next meeting, the club unanimously resolved

In the weightlessness of space, a 3-mile-square surface covered with solar cells could be assembled from thin, prepackaged, weblike structures that would weigh in total no more than 3,000 tons on earth. Its photovoltaics would gather a prodigious 10 gigawatts of solar power. Such a system could end the earth's dependence on nonrenewable energy.

While air travel was from the beginning conditioned by the presence of people and the harsh atmospheric environment, neither one is a necessary factor in space.

to consult the director of the University Observatory in Cambridge, Mass., for further information. The response arrived three days later:

☐ The cannon must be located in some country lying between 28° north and 28° south.

☐ The cannon must be aimed directly at the local zenith.

☐ The projectile must possess an initial velocity of 12,000 yards per second, just as Barbicane proposed.

☐ The projectile must be launched on the first of December 1866, at exactly 1 minute and 13 seconds before midnight.

☐ The projectile would meet the moon four days later at midnight precisely, the very moment the moon reached the zenith.

One hundred years after Jules Verne proposed this scenario, humanity had in fact found how to give a projectile the necessary velocity and how to guide it with a more sophisticated device than the inner wall of an iron cylinder—an inertial guidance system. And Barbicane's dream for "the Columbuses of another new world" had indeed moved from fiction to reality.

The fiction of the past has become the reality of the present in other ways, too. The myth of Icarus and the ingenious though naive idea of Leonardo da Vinci have matured into supersonic aircraft and even human-powered flight in the form of the *Gossamer Condor* and *Gossamer Albatross*. Yet Verne's dream of the nineteenth century became reality long before the ancient dream of Icarus. Clearly, it is difficult to foresee what will remain fiction and how that subtle metamorphosis from fiction into reality will occur. Where do such ventures as the space tower, self-reproducing robots, and exponentiating systems lie along the spectrum that links fiction and reality?

Studying the Space Environment

During the past 20 years we have learned the fundamental difference between the dynamics of a spacecraft in orbit and that of a rocket during launch. Some of the knowledge we now take for granted was not anticipated:

☐ The stability of the space environment—the absence of unpredicted disturbances and random forces.

☐ The significance of very small external forces (atmospheric drag, gravity-field harmonics, electromagnetic interaction, and radiation pressure) in the long-range behavior of spacecraft.

☐ The significance of thermal phenomena in the spacecraft—for example, the heat of friction and differential solar heating.

☐ The fact that the laws of physics apply with exquisite precision to bodies ranging from micrometeorites to spacecraft and even to planets. For example, we detected the minute variations in the angular velocity of *Explorer XI* caused by thermal contraction and expansion as the satellite moved in and out of the earth's shadow.

☐ The evolution of mathematical techniques for reliably predicting the behavior of very complex systems in space to very great precision. These achievements are based mainly on the availability of digital computers.

☐ The necessity of designing a spacecraft able to withstand the large stresses of launch and yet responsive to the vastly smaller stresses (mostly thermal) in space.

☐ The ability to deal with the grossly different time constants typical of spacecraft during launch (ranging from milliseconds to minutes) and orbit (measured in hours and days).

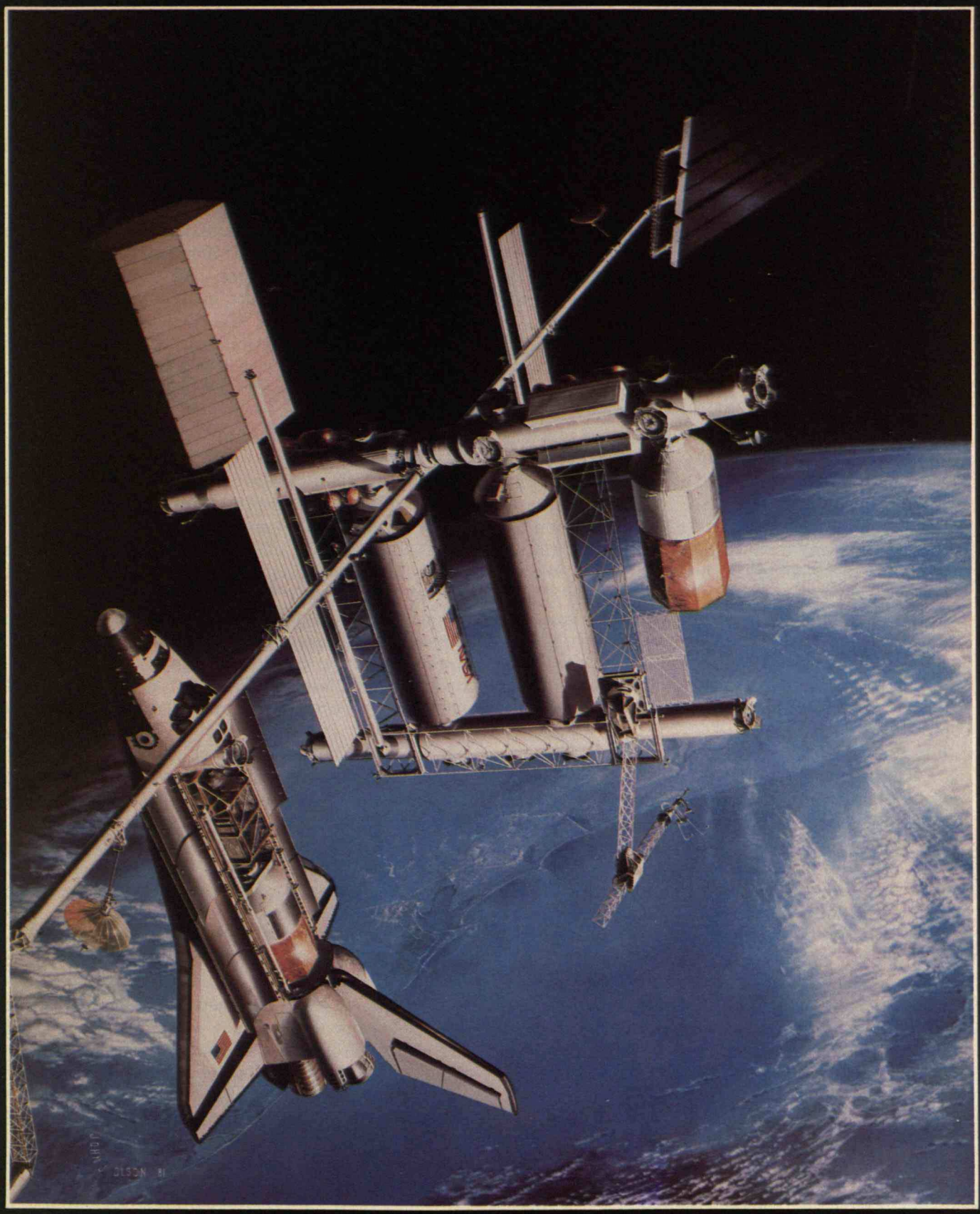
☐ The effect on research of the high cost of a space mission. It is not sensible to spend $10 to $40 million to launch a $200,000 experiment that fails in flight; redundancy is necessary in all experimental apparatus.

☐ The fact that even though space technology is descended from aeronautical technology, there are essential differences between them. Both involve very light but strong structures and similar principles of avionics (control, guidance, and communications). But aeronautics has been from the beginning conditioned by its role as a transporter of people and by the harsh, variable atmospheric environment. Neither has been true in space.

Lessons from People in Space

Our success in putting humans in space in the 1960s produced a transient excitement that heavily influenced present space technology. The lunar landing gave the impression that, after all, a manned mission was easier than we had thought. We lost track of the fact that the few tens of minutes required for the transfer of a spacecraft from ground into low-earth orbit and return are extremely critical when compared with the rest of a mission and we ignored this knowledge in the development of the space shuttle.

The extraordinary success of the Apollo project



The next extension of the U.S. presence in space will be a big one—a space operations center (*see page 41*) to serve as a destination for the shuttle, a station for U.S. space research, and a staging platform for orbit-bound equipment. Cylinders with connecting passageways will contain command control center, living quarters, and laboratory; service modules below the cylinders will contain power units, life support systems, and communications. There will be a docking base for the shuttle (lower left), and there may be added in the future a construction base for assembling satellites and an operating base for the orbital transfer vehicles that will range outward from the operations center.

People should have a role in space, but only in situations that exploit their cleverness, adaptability, and imagination—characteristics that cannot be simulated by computer.

had at least two other negative effects as well:

☐ It led us to overconfidence in design. We significantly underestimated the difficulty of developing a thermal protection system for the shuttle. Very few tests, almost all on the ground, were programmed for the shuttle; its first real test carried astronauts—a payload of very high political, social, and psychological value—into orbit, and failure could have been fatal for the entire program.

☐ Because humans were aboard the Apollo flights, there was no need for basic advances in space robotics. As a result, our success in the use of automatic instruments in acquiring and managing of information from space during the recent Voyager missions contrasts with a much lower rate of progress in automation for launch systems and manned flights. If we are now to progress to those activities that can provide energy resources from space to an ever-expanding society on earth, we must pursue more sophisticated research and development efforts in automation. People should still be used in space, of course, but only in situations that exploit their cleverness, adaptability, and imagination—characteristics that cannot be simulated by a computer.

For example, full exploitation of advanced automatic controls and robotics should make possible a reusable transportation system far less expensive than the manned space shuttle to operate between earth and low-earth orbit. Had the choice been made only on the basis of technology, the first space shuttle would have been an unmanned, reusable two-stage vehicle with a limited orbital lifetime, possibly delivering its payload and returning to earth in only one revolution. While the space shuttle system will actually reduce perhaps by half the cost of transportation to near-earth orbit, the original promise was for a cost reduction of at least an order of magnitude. Such a substantial reduction would have generated dramatically increased interest in the exploitation of space resources.

A Shopping List for the Near Future

How fast will space technology evolve in the remaining part of this century? The answer is not very clear. Conditions in the third quarter of the century were highly favorable for space research, but we now confront increasing energy problems and worldwide inflation. Traditional solutions that avoid high risk are likely to take precedence over large investments in the exploitation of space for nonmilitary purposes.

Yet there remains among engineers and scientists great interest in the construction and use of large structures in space—astronomical observatories, communications equipment, and solar energy systems. And rapid advances in defense-related space technology by both the U.S. and the Soviet Union may well change dramatically the economics of related civilian space efforts such as a solar power station.

In the next two decades, the shuttle will enable us to bring masses of experimental equipment—sophisticated electronic components, highly sensitive instrumentation, and powerful communications and data-handling capabilities—into space to be assembled and deployed in these large structures (*see "Implications of the Shuttle: Our Business in Space," page 34*).

A space platform of 10 to 100 tons with a power supply of at least several hundred kilowatts—perhaps one megawatt—will be developed and deployed in low-earth or geosynchronous orbit in the 1990s. Soon thereafter will come astronomical observatories—sophisticated platforms with large assemblies of optical and radio telescopes. Spacecraft orbiting the outer planets will be essential for understanding phenomena such as those observed by the Voyager spacecraft. A comparative planetology, which can come only from extensive exploration, will be necessary for exploiting other planets' resources and for fully understanding the earth's geophysics. Spacecraft that pass close to the sun or even impinge on it will be essential for understanding the solar atmosphere and interior.

Building, operating, and maintaining large space assemblies will require advanced mechanical systems—teleoperators (that is, control from afar), robots, and manned and unmanned manipulators. The sophisticated integration of teleoperators and robots into fully or partially automated systems will be the next achievement of the new space technology, and the role of people in space will be correspondingly reduced, eventually limited to the very few systems that require direct intervention of human intelligence. Delivery of complex scientific systems to orbit will be possible only with a space operations center serviced by the shuttle. It is in this role that the space shuttle can be of revolutionary importance.

The Far Future: The Sky's the Limit

From the perspective of the twenty-first century, the space shuttle will seem but a primitive beginning. By then we shall be transporting goods and services in addition to communication and information to earth

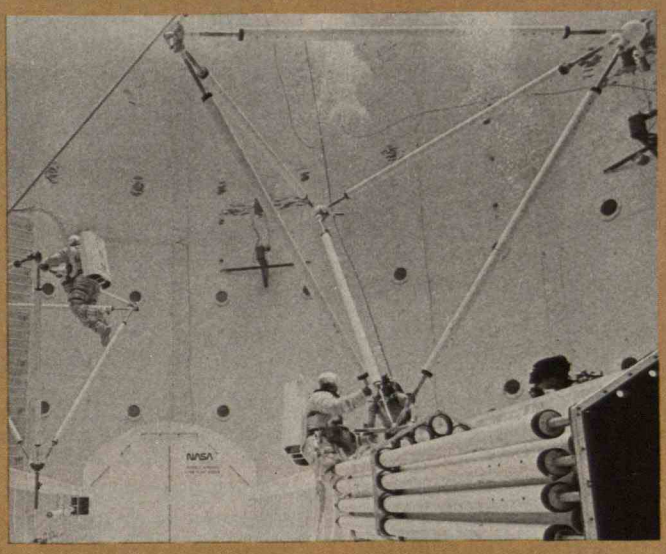
How a Lunar Factory Could Build a Solar Power Station for $1.08 Billion

CAN large structures—satellite solar power systems, for example—really be built on the moon using materials from the moon itself?

Writers of science fiction now have some solid justification for this idea: after three years of study, including tests in the neutral-buoyancy tank at NASA's Marshall Space Flight Center, Professors René H. Miller and James W. Mar have concluded that the cost for ten or more satellite power stations (SPSs) will be less if they are made on the moon than if they are made on earth. Furthermore, analyses of the lunar samples returned by the Apollo astronauts give Professor David Criswell of the University of California at San Diego confidence that the moon itself can yield the raw materials for such factories.

The M.I.T. study concluded that about 50,000 tons of aluminum, solar cells, and miscellaneous communications gear would be required for one SPS. According to Professor Criswell, using the shuttle to put such material into orbit from the earth's surface is likely to cost no less than $1,000 per kilogram; later launch systems may eventually reduce that price to $30 to $50 per kilo. But to put one kilogram of lunar material into orbit by electromagnetic catapult from the moon may cost no more than 10 cents.

Raw materials for glass and ceramics apparently abound on the lunar surface, and many other minerals—including the raw material for aluminum—are also thought to be present. Refining lunar materials from their ores may not be so difficult, says Professor Criswell. Solar energy is abundant, and even a small collector on the lunar surface can produce high-temperature heat. Because the lunar soil is fine grained, particles could be sorted according to size and composition with gravitational, electrostatic, and magnetic separation techniques. For example, iron could probably be removed from lunar soil and rocks magnetically, and oxygen could probably be obtained by electrolysis. Lunar-made glass might be optically superior to any made on earth because it could be made completely anhydrous—lacking in hydrogen.



In the neutral buoyancy tank at NASA's Marshall Space Flight Center, M.I.T. graduate students learned that they could quickly adapt to a weightless environment and be at least as productive in the tank as on dry land. (*Photo: NASA*)

In-space manufacturing is "the greatest technical challenge of all," according to Professor Miller: how to design and economically operate a space factory that receives most of its raw materials from the moon, logistic support and some raw materials from the earth, and all its energy from the sun. The factory would also have to manufacture solar photovoltaic cells for the SPS a hundred to a thousand times faster than today's terrestrial factories.

The M.I.T. team studied the feasibility of an automated photovoltaics factory in which solar-cell materials are deposited in layers on moving sheets, which are then cut into individual cells and built into arrays. (There are some advantages to working in space: the principal requirements for producing silicon wafer are vacuum and energy, and both would be cheaply available.) The team also began designing machines to produce STS components and a free-flying hybrid teleoperator for on-site repairs. Professor Criswell, in turn, has made conceptual studies of a factory that would produce 30,000 tons of glass a year from lunar materials. Such a factory could be built on the moon with only 500 to 800 tons of low-mass, high-technology items such as integrated circuits imported from earth.

Productivity Without Gravity

How productive would weightless workers in the space environment be? For terrestrial industries, productivity, in terms of kilograms of materials handled per person per unit of time, ranges from 2,500 (in mining) down to 1 (in aerospace manufacturing). Studies at M.I.T. and the Marshall Space Flight Center's neutral-buoyancy facility suggest that each worker on the moon and in space could handle 600 kilograms per hour. The advantage of weightlessness in moving large masses would be offset by the encumbrance of a space suit, especially the gloves.

A space manufacturing plant capable of producing one 10-gigawatt SPS per year might cost $10.73 billion and could be operated by fewer than 400 people, including 200 support and housekeeping personnel, for $1 billion a year. The cost of manufacturing a satellite power station (excluding additional costs for the lunar base and earth-based facilities) would be about $1.08 billion. Development costs might be $70 billion for everything—design of the SPS, the space manufacturing plant, the lunar mining and launch facilities, and the transportation system required to bring SPS components from the moon to the final erection site in earth orbit.

Transportation of the SPS from the moon to its final orbit would be accomplished by an electromagnetic catapult, or mass driver, according to Professor Criswell. Magnetic coils are spaced along aluminum guide rails. When power is applied, these coils exert an accelerating force on coils attached to any container that rides the rails. The container thus acquires ever-increasing speed, and when it is suddenly halted at the end of the track its payload is ejected into orbit.

Five hundred tons of earth-made materials would be required for a catapult that could launch 30,000 tons of lunar materials a year. If solar cells instead of conventional solar-charged batteries were used for energy, annual capacity might reach 3 to 6 million tons.—*J.M.* □

How to deliver a 40-ton package into orbit 400 kilometers above the earth. The space shuttle brings the package to the 200-kilometer level, where it is collected by a docking teleoperator—a remote-controlled "skyhook"—deployed from a spacecraft in orbit at 400 kilometers. As it receives and hoists the payload, the spacecraft is drawn out of its circular orbit; but its on-board ion propulsion system can return the spacecraft with its new burden into normal orbit within about one week.

from space on a vast scale, and space systems larger by at least two orders of magnitude than any thus far attempted will be required.

A collecting surface 10 kilometers square in space could gather 10 to 100 gigawatts of solar power. Hundreds of such collectors gathering solar flux otherwise lost to the earth could provide energy equivalent to present world demand. This flux could either be beamed directly to the ground or converted into electrical energy in space and transferred to earth by high-power microwave beams. With such collectors we could change by nearly 1 percent the solar flux reaching earth—either adding to it by reflecting additional energy or reducing it by shadowing. A few large power stations in synchronous orbit could potentially provide power for minor weather intervention on the ground, such as dispersing fog and protecting tender crops from frost. With more powerful stations we might provide weather and even climate control, perhaps coping with changes in climate caused either by natural forces or human activity.

We could fully control the solar flux on earth with a system of perhaps 10 million free-flying solar collectors in the vicinity of the Lagrangian point between the earth and the sun, where the gravitational pull of earth is balanced by that of the sun. Such a collection of solar sails is clearly within our present technological capability. If each element weighed 10 tons, the total mass of the system would weigh perhaps 10 billion kilograms. This is a much smaller mass than that produced every few years by the present world automobile industry, and building the system on earth would be feasible within no more than 100 years.

However, a bottleneck remains: it is difficult to conceive of any way to transfer into orbit by conventional rocket propulsion a mass of billions of kilograms of manufactured material without deteriorating the earth's environment. Hence the concepts of the "synchronous skyhook" and the "orbital tower." The latter is a relatively old science-fiction idea that works like this: Assume that you have a satellite in goestationary orbit over the equator. A ten-mile-long ladder can be dropped toward the earth without destabilizing the satellite if an equivalent mass is erected on its opposite side, away from the earth. Carried to its extreme, this idea leads to a great tower extending from earth to the point of geostationary orbit and beyond. A ballast weight located 200,000 kilometers from the earth's center that is 12.57 times as massive as the largest weight to be lifted up the tower at one time would enable us to transport material from the ground to geostationary orbit; a larger ballast would permit such goods to achieve escape velocity. Conventional materials do not meet the requirements for

Slicing the Pie in the Sky

by Steven L. Solnick

THERE is no such thing as a free ride—especially into orbit. But given the recent escalation of Third World demands for a new world economic order, it is becoming increasingly difficult to tell which entities should, and will, benefit from commercial escapades in orbit and beyond. This uncertainty is complicating the plans of space enthusiasts and scaring off many potential investors. And without investors who stand to gain from space exploits, no technology—no matter how ripe—will ever see starlight.

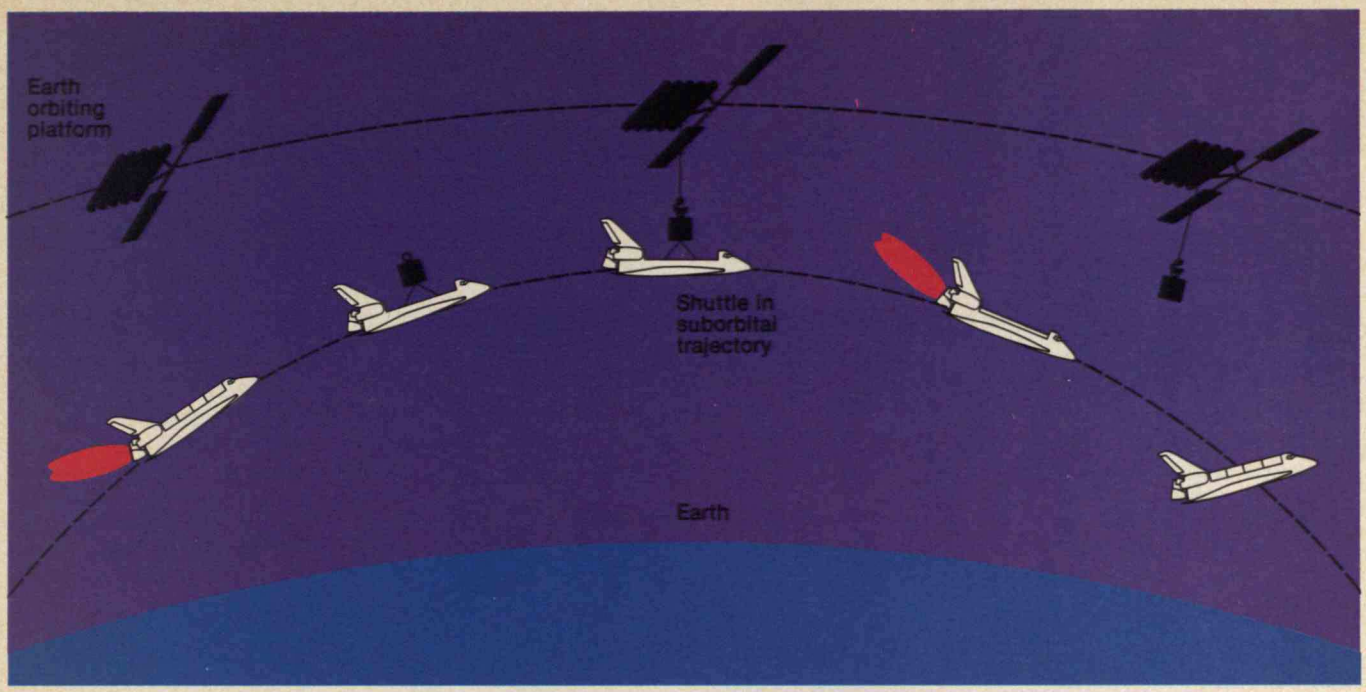
Here's Looking at You

In the mid-1970s NASA launched a number of remote sensing satellites: the ERTS and the Landsat series. These systems were able to detect potential oil and mineral sites, forest cover and density, crop yields, and other resource-related data. The satellites also raised a small storm of controversy in countries that felt there should be controls on which nations could be surveyed, with what resolution, and for whose benefit.

Specifically, a number of developed and developing countries charged that access to information about their resources posed a threat to national sovereignty. They claimed that it was possible for multinational corporations to gain access to data about mineral-rich areas and then buy into them even before governments became aware of their own resources. Landsat in particular makes it possible for the United States to know more about a nation's crop yield than the nation does.

The issues appeared in a new form at the 1979 World Administrative Radio Conference (WARC), held to discuss allocations of radio frequencies and global communications. Although the 1959 WARC of 87 nations, in the words of one observer, had been run as a "club of the industrial countries," the International Telecommunications Union's WARC in 1979 featured 154 countries and was dominated by Third World participants. Charging that the radio spectrum was the "common heritage of mankind," they sought to break the West's monopoly on the gathering and dissemination of information. Furthermore, the developing countries' "Group of 77" spoke of a new World Information Center, through which the Third World would manage the flow of information about it, to it, and from it.

The catalyst for the Third World's demands, and one of the tools it most sought access to, was the developed countries' satellite communications technology. At WARC, as during debates over resource satellites, participants found that each of the 40 supposedly "technical" agenda items actually involved north-south (rich-poor) issues.



mass and strength of such an orbital tower, but a cosmic elevator cable made of crystalline graphite could support one six-thousandth of its mass. Is this structure any less attainable for us than was President Barbicane's dream of placing a projectile on the moon in the nineteenth-century world of Jules Verne?

The same principle could be more realistically applied to the construction of a "non-synchronous skyhook" in orbit at an altitude of 400 kilometers. From a 1,000-ton platform at that altitude we could drop a cable system with a teleoperator to the 200-kilometer level, where the velocity would be several hundred meters per second smaller than at the orbiting station. Even the present space shuttle, far from an optimal vehicle, could deliver material to the teleoperator, whence it could readily be lifted to the 400-kilometer level. An ion propulsion system based on the upper facility—technically feasible today—could move a 40-ton load from 200 to 400 kilometers and bring the system back to its initial configuration in about one week. Increasing the mass of the upper facility, the length of the cable system, and the power of the propulsion system would enhance its capability. The same technique of tension transmission through a long tether could simplify transportation to geostationary orbit, the moon, or the Lagrangian point.

Too Many Bakers?

The Third World crusade for a share of the benefits from space has culminated in the U.N.-negotiated Agreement Covering the Activities of States on the Moon and Other Celestial Bodies. This so-called "Moon Treaty" expands on the 1967 Outer Space Treaty, which declared that "the exploration of . . . the moon and other celestial bodies shall be carried out for the benefit and in the interests of all countries . . . and shall be the province of all mankind."

The Moon Treaty, signed in 1979 but not yet ratified by the Senate, declares the moon—and all other celestial bodies, such as asteroids—"the common heritage of mankind." This theme echoes the WARC debate and also much of the decade-long Law of the Sea negotiations, another north-south division-of-benefits battleground.

The treaty invalidates the concepts of national appropriation or colonization of the moon (and other celestial bodies), commits signatories to form an "international regime" to govern the exploitation of lunar resources, and prescribes "an equitable sharing by all parties in the benefits derived from those resources, whereby the interests and needs of developing countries . . . shall be given special consideration."

The original concept of the Moon Treaty was proposed by Argentina, with the aim of preventing the kinds of misallocations of benefits that had frustrated the country in the ERTS and Landsat cases. It represents the Third World's bid, well before the technology for exploitation of the moon comes into view, to ensure its share of the profits.

However, critics of the treaty have pointed out that the mandated international distribution of lunar wealth—without specific property or resource rights—reduces the prospects for private commercialization. Although there is validity in the claim of "common heritage," that claim may render the exploitation of the moon and beyond unprofitable. In the words of one space lawyer: "Resources owned by everybody are developed by nobody." (At least four deep-sea-mining consortia have abandoned seabed projects, citing the elimination of financial incentives by the draft Law of the Sea's articles on common heritage.)

Many futurists and science-fiction writers have claimed that the solution to the small pie of resources on earth lies in developing the riches of space. That may be, but if Third World countries are successful in claiming a larger fraction of the larger pie, they may find that the bakers have left town, at least for a while. □

Steven L. Solnick, former editor-in-chief of The Tech *(M.I.T.'s student newspaper) and a frequent contributor to* Technology Review, *is currently a Marshall scholar at Oxford University.*

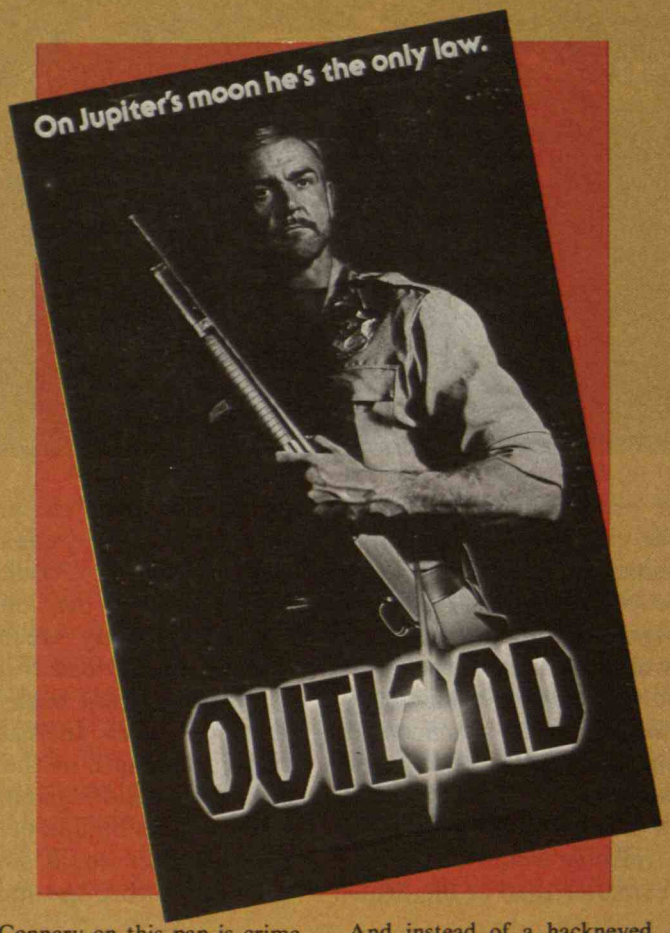
Tunnel Vision in Space

by Steven J. Marcus

WHEN the man has a mine on the moon; when we colonize far-flung locales of space; when the energy of the sun is truly harnessed for the benefit of the earth; when today's "communications revolution" is antiquated; when computers, robots, and person-machine interactions of every sort will have become systematized, prioritized, and optimized—what then will we, the clever inventors of it all, be like? Will human nature have kept pace with our technology? Or will we still confront the same moral dilemmas and human frailties—your basic man's-inhumanity-to-man scenario—in a new, celestial, but not especially improved environment?

According to *Outland* —a recent, heavily financed, but unmemorable film—and *Alien*, a far more imaginative precursor, we will simply be the same old shlemiels in space suits. We may be extracting titanium from Jupiter's moon Io (*Outland*'s scene), or routinely navigating interplanetary freighters (where *Alien*'s action takes place), but our minds—even our language—will still be in the gutter. According to Hollywood, it seems, we will look, sound, think, and behave just as we do today.

Outland is a Western in space, complete with a marshal and hired gunslingers. The plot is straight from *High Noon*, but the quality is not. The dialogue, for instance, is a treasure trove of clichés from every cowboy picture, as well as every prison, factory, cops-and-drug-dealers, underworld, and ghetto picture, ever made. To waste an actor like Sean



Connery on this pap is crime enough, but to extrapolate from the Old West or even from the present without the slightest bit of imagination on how jobs, work places, and relationships will change is to completely squander the story and the medium.

Why, for example, do human miners in klutzy "environment suits" hammer away at Io's inhospitable surface? Such nasty mining jobs might have been handled by remote-controlled systems or by artificial intelligents—they could even be humanoid, like C3PO of *Star Wars*' fame, or vacuum-cleaner cute, like R2D2. And instead of a hackneyed mining town we might have had a power-plant control center, a high-tech production module, or an administrative "office of the future"—with the possibility of some new and timely material. But we simply have the same old derivative shadow of a plot in electronic drag.

Alien is more stimulating. Where *Outland*'s people are one-dimensional, *Alien*'s are believable—a "blue-collar crew" (as one critic called them) that operates a space ship but remains down to earth. An interesting element is *Alien*'s portrayal of a non-sexist future: the crew has similar numbers of men and women, there is no contrived love interest, and both sexes display comparable levels of courage, resourcefulness, and cowardice.

But the fact that these people are portrayed just like people today—even to their slang and styles of dress—suggests that the filmmakers didn't especially want to think, perchance to dream. An important function of storytelling is to stimulate our imaginations, expand our vistas, and loosen our intellectual constraints. And since the boundaries of space are virtually limitless, why should writers of space stories keep working the same tired old earthly plots?

The astounding technical possibilities for ventures and *ad*ventures in space offer a challenge not only to scientists and engineers but to humanists—our artists and writers—and all other social thinkers and tinkerers. We have learned at least one thing since the advent of the Industrial Revolution: we should not expect our technology to change *us*; we must change *it*. That is, we must continually devise new and better ways to improve life and enable humanity to blossom. Technologists play a key role in implementing—but not in defining—these goals. Our dreamers, and our tellers of tales and singers of songs and sayers of sooth, should be constantly challenging and shocking us with far-out visions of the future that may then be ours to choose and shape. □

Steven J. Marcus is managing editor of Technology Review.

We can draw from the sun the energy necessary for the preservation of the human species in its natural habitat; the Earth can become one unlimited garden.

Technology in the Sky

To most of us, earth-based manufacture of space systems large enough to provide energy for a high standard of living on earth (containing as much as 10 billion kilograms of material) is inconsistent with the preservation of the earth's natural environment. The alternative is the industrialization of space and the exploitation of the bountiful resources of other celestial bodies—the moon, asteroids, comets, and planets.

In *The Search for Extraterrestrial Technology*, Freeman Dyson hypothesizes a highly technological extraterrestrial society that disintegrates planets, moves stars, and even organizes galaxies. Although this bold vision is far from possible using present technology, it is within all basic physical principles. Much less ambitious concepts for colonizing the moon and capturing an asteroid in earth orbit for exploitation of its mineral resources are familiar in today science fiction. However, no basic technological breakthroughs would be required to achieve these goals; even the exploitation of Mars' environment and resources is considered practicable.

For example two types of lunar-based industrial systems for making solar collectors to control the earth's environment have been considered:

☐ *The linear concept*, which calls for one or more self-contained factories on the moon to manufacture solar collectors using abundant lunar aluminum, titanium, and silicon for sail-like solar collectors. Lightweight, "intelligent" components would be supplied from earth. A lunar factory weighing perhaps 100 tons might produce a space solar system utilizing 10 billion kilograms of aluminum, titanium, and silicon in 60,000 years!

☐ *The exponentiating system*, in which a single, highly sophisticated materials-processing and construction facility is sent to the moon. There this system utilizes lunar materials for building large solar energy collectors and, at the same time, builds additional factories in which collectors can be built. Under this scenario, a 10-billion-kilogram solar energy system with 10 million collectors might be constructed and assembled in 20 to 30 years.

Needless to say, building either of these lunar industrial systems would require major technological progress in space transportation and automated and remote-controlled factories. The development of a linear system is, in principle, within our present technological capability. On the other hand, the development of an exponentiating system depends on a technological breakthrough—the achievement of a self-reproducing robot much to philosophy as to technology. The reality of tomorrow will probably lie somewhere between the inefficient linear system and the exponentiating one.

Heaven on Earth

The ancients believed that the sky is only for souls, that people are bound to earth, and that all things controlling human life come from the sky as the gifts or the wrath of the gods. This is the origin of our perception of space as a hostile environment and our assumption that space is an arena beyond human colonization—to be exploited only by a few uniquely qualified scientists and astronauts and their automated servants. But in one generation, the space venture has brought unpredictable results, and there is every reason to believe that space will continue to yield such revelations and values in the future.

We know that the higher standard of living now sought by the developing nations will require larger amounts of energy and other resources than are available on earth, and we know that these resources are within our grasp in space. Along the continuum from the space shuttle to the earth-made lunar factory to the exponentiating system are enterprises that, though considered fiction today, will become reality tomorrow. The fact that we have not yet undertaken many technically feasible projects to bring the resources of space to bear on our urgent needs on earth suggests that the line between reality and fiction depends not on science but on social and political factors. Only an educational process bringing scientists and laypeople ever closer in their understanding of the space environment, space science and technology, and our social and material needs can lead to sensible judgments about what should remain fiction and what should become reality and how we can best use the resources of space to preserve the human species in its natural habitat.

Giuseppe Colombo is a member of the Institute of Applied Mechanics at Padova University in Italy; he also works in celestial mechanics at the Center for Astrophysics in Cambridge, Mass., and at the California Institute of Technology. This article is adapted from his Minta Martin Lecture at M.I.T. in 1980, when he was visiting Hunsaker Professor in the Department of Aeronautics and Astronautics.

TRENDS



Environment

The Greening of the Sludge Business

"We have to serve notice that the cheap way is no longer the accepted way." So declared Representative William J. Hughes (Democrat of New Jersey) in 1977 as he introduced an amendment to the federal "Ocean-Dumping Act" that soon became a ban on the disposal of sewage sludge at sea. And the law stands: by December 31, 1981, a number of coastal cities—*big* ones such as New York, Baltimore, and Boston—must "get out of the ocean."

It is not an absolute ban—the sludge is taboo only if it "unreasonably degrades" the marine environment. But the Environmental Protection Agency's criteria—allowable pollutant levels in the sludge—are stringent enough that most urban sources, with their diverse industrial and runoff-derived constituents, simply cannot meet them.

The response in New York, which has been dumping sludge into the ocean for 50 years (currently some 260 tons per day), was unenthusiastic, even hostile, as officials expressed grave concern over the prodigious institutional problems and short-term changeover costs that adoption of alternative disposal options—such as burning, burying, or using the sludge—could entail. And the attitudes of some regulators, although well-intentioned, rubbed salt in the wound. Gerald M. Hansler, then director of EPA's New York office, advised city officials to "grind up piers, debris, and drift material" to help make the sludge into compost.

But the city received unexpected support early this spring when a presidential study group, the National Advisory Committee on Oceans and Atmospheres (NACOA), capped an 18-month study by suggesting that the end-of-1981 deadline be extended. As a matter of fact, added its director, "Scientific information now available does not support a complete ban on ocean disposal of wastes." Shortly thereafter, a federal judge ruled that the EPA could not stop New York from ocean dumping. The EPA, he said, simply had not demonstrated that New York was unreasonably degrading the marine environment.

NACOA went a lot further, maintaining that EPA had failed to develop a comprehensive approach to waste management and had instead produced a "fragmentary regulatory system." The *New York Times* joined the chorus, editorializing that EPA had been "regulating with a vengeance." It cited the case of an about-to-be-completed $14.5-million sludge-dewatering plant in Wantagh, Long Island (for incineration or easier land disposal of the sludge) that might never be used—"the price of foolishly narrow environmental regulation."

Judging from New York's "victory," it might appear that the sludge worm has turned. But according to Robert K. Bastian, a pollution-control specialist at EPA's Office of Water Program Operations in Washington, this is more the exception than the rule. The trend, he maintains, is for cities to recognize sludge as a resource instead of a useless waste with an inevitable price tag for disposal.

Philadelphia—long a polluter of its marine environment—was out of the ocean a year ago through application of a "backhaul concept": Trucks from western Pennsylvania coal fields, on their otherwise-empty return trips, carry Philadelphia's sludge (suitably dewatered and composted) to help reclaim strip-mined land. After two successful years of pilot-scale operation, most of Philadelphia's 70,000 tons this year will be used to reclaim land in rural Somerset County. A private intermediary, Modern Earthline Co. is playing a key role in this arrangement and is conducting another demonstration, in a rural Maryland county, for the constructive use of Baltimore's sludge.

There are similar cases, large and small, across the country. Chicago has recycled all its sludge into land-based applications for several years. The Kellogg Supply Co. has been transforming Los Angeles-area sludge into a line of horticultural products since the 1920s. Camden, N.J. and Durham, N.H. compost their sludges. Milorganite—a much-appreciated soil additive—is "the sludge that made Milwaukee famous." And many a Midwestern farming town simply deposits its sludge directly onto local fields.

New York, of course, as well as many a lesser Gotham, has no fields immediately nearby. But even when transport distances and costs are reasonable, heavy metals in urban sludge can be worrisome: cadmium in particular has been the single greatest reason for public and administrative resistance to land-based alternatives. But it is important to distinguish between disposal and use, between a waste and a product. Nonbiodegradable pollutants accumulate at a disposal site—a "landfill"—where ton upon ton of sludge is deposited, and these can leach into and contaminate local water supplies. But if sludge is used as a resource (say, as a topsoil substitute for landscaping highway medians), it is used sparingly: a little bit stretches a long way. Horticultural



ILLUSTRATIONS: JIM CHIROS

and landscaping uses are the safest, but even in agricultural applications, the proper selection of crops (such as corn) and careful soil management practices (such as pH control) minimize metals uptake.

It is difficult to regard a classically noxious by-product—human feces—as a resource, especially when highly diluted in water and spiked with industrial pollutants. It is equally difficult to expect sanitary engineers and other technical specialists to be comfortable as salespeople and entrepreneurs. But communities are realizing that "comprehensive waste management," precisely what NACOA suggested, can be at once environmentally, economically, and politically rewarding.

This is especially true now that changing economic conditions require that cost data be analyzed with the long term in mind. "In New York," says EPA's Bastian, "least-cost currently means 'let's continue to do what we're already doing.' Yet that may not be possible. Even if the ocean-dumping criteria were relaxed, permissible sites at sea may be much farther out and costs would therefore increase."

But overall, the trend will be to convert pollutants into products. As Professor William E. Sopper of Pennsylvania State University's Institute for Research on Land and Water Resources has observed, "Philadelphia's problem is turning into a solution for Somerset County."—*S.J.M.* □

Fundamentals

Some Most Fundamental Villains

Most of us first encountered the fundamental constants of physics in textbooks, where their violation is forbidden, and in science fiction, where liberties are sometimes winked at. But now these constants have come to life as villains in the race to make ever larger, faster information-handling systems. Here are three examples, as described by Professor David Adler of M.I.T., an expert in the new class of materials called "amorphous."

The constant most of us think of first is the speed of light—186,000 miles per second. As information systems become ever larger, more complex, and more nimble, the time required for electrons to move through the electronics approaches that required to perform the operations. The speed of light, then, forms a ceiling on the speed of the system.

Heat dissipation in a computer is leading information scientists to a confrontation with a second fundamental limit with roots in Boltzmann's constant, an expression for the energy content of a material depending on its temperature. Professor Adler explains it this way: the memory element in a digital computer can assume either of two stable states, *0* or *1*. When it goes from one state to the other, energy is released as heat inside the computer, the amount of which is a function of Boltzmann's constant. At room temperature, the heat for one transition is 3×10^{-21} joules—not very much. But the entropy generated by the enormous number of transistors proposed for tomorrow's computers may cause trouble.

Perhaps a year ago, Professor Adler and his colleagues added a third fundamental limit to this roster of villains: the minimal size of a conductor through which electrons can pass. That limit is set by the characteristics of electrons and atoms: if current is to flow, a conductor must be larger than the mean free path for conducting electrons—about 100 angstrom units, roughly one-millionth of a centimeter. Conductors this small are feasible enough by electron-beam and x-ray lithography. But the mean-free-path problem puts a ceiling on the number of conductors on a computer chip over which lithographic technology has no power whatsoever.—*J.M.* □

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Neutrinos: Have Energy, Will Travel

The key to the mysteries of the most distant and violent galaxies in the universe may lie deep under the coastal waters of Hawaii. An international team of astrophysicists is currently testing an underwater device that will detect neutrinos—subatomic, chargeless, nearly massless particles that bombard earth from space. The neutrinos originate from dense concentrations of matter such as quasars and Siefert galaxies, the scene of violent reactions and the source of extremely high levels of radio waves. Analysis of the energy content of the neutrinos could lead to quantum improvements in our understanding of these phenomena.

According to Robert March, a member of the research team and physicist at the University of Wisconsin at Madison, until now all study of distant galaxies has been done in the electromagnetic spectrum. But electromagnetic particles radiate from the surface of stars and give us little clue about the dense cores, where the action is.

Neutrinos are different: they penetrate but rarely interact with other matter and thus can come straight from the core. But because they are so inert, neutrinos are extremely difficult to detect. To study low-energy neutrinos from the sun, scientists have buried detectors in mines beneath hundreds of tons of earth to screen out interference from cosmic rays.

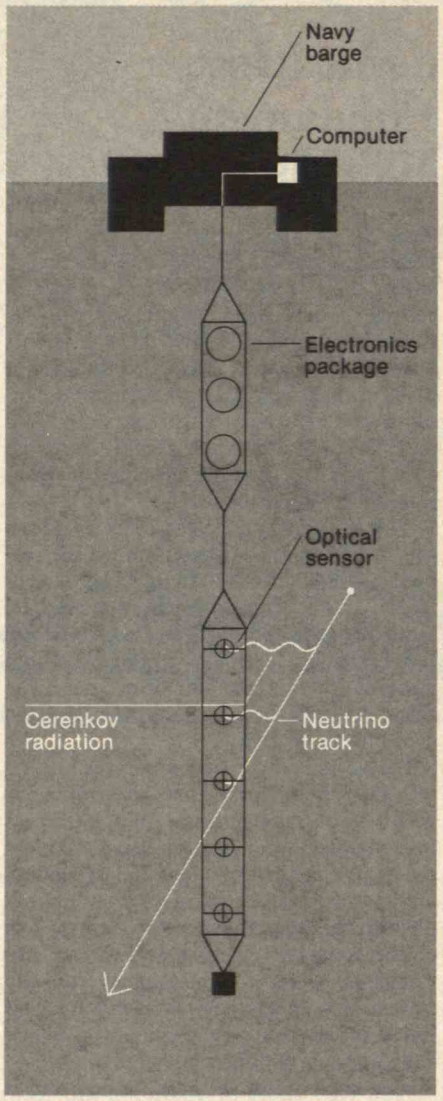
Seawater will have the same screening effect in the case of the Hawaiian experiment, in which 2,000 of the world's most sensitive light sensors will be housed in glass spheres arranged in a grid pattern over a square kilometer of ocean floor. These sensors will detect the characteristic flashes of light, known as "Cerenkov radiation," created when neutrinos collide with other subatomic particles. These flashes will be registered in onshore computers connected to the sensors by underwater fiber-optic cables.

John E. Learned, associate director of the project and visiting associate professor of physics at the University of Hawaii, says the project will represent the largest area ever monitored by phototubes. Computers analyzing events recorded in different parts of the grid will allow physicists to determine the galactic source of the neutrinos to within one degree.

Although scientists are not predicting what they will find with DUMAND (for "deep underwater muon and neutrino detector"), they are optimistic, says Dr. March. "Every advance in telescopes has produced discoveries no theory predicted. This detection device will open a new window on the universe, and who knows what we will find?" At the very least there is likely to be new information for oceanographers on bioluminescence (flashes of light emitted by marine organisms) and the marine environment at these depths.

In part, success of the project hinges on development of a glass sphere that can withstand the 10,000 pounds per square inch of pressure exerted by the sea at the depth chosen for DUMAND. A prototype glass sphere is being lowered this fall.—*S.L.H.* □

A sketch of the string of phototubes being lowered off the coast of Hawaii to detect Cerenkov radiation, emitted when neutrinos interact with other particles. Scientists hope to learn more about the most distant and violent galaxies that produced the neutrinos.



OMNIGRAPHICS

Engineering Education

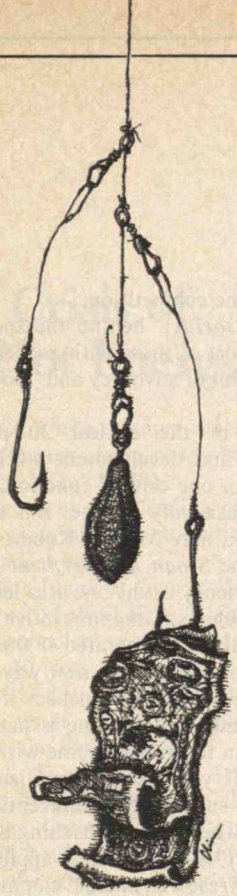
Is There a Doctor in the House?

Less than a decade ago, college courses in circuit design and structural mechanics were about as popular as milk at a beer blast. Whether put off by the brief job-market lag of the late sixties and early seventies, convinced by antitechnology rhetoric, or simply swaying in the prevailing wind of fashion, students simply were not interested in engineering careers.

Economics, among other things, has changed all this. Today's undergraduates stand in line to sign up for courses in semiconductors and gas-turbine design, and as quickly as these aspiring engineers glean the rudiments of their craft they are gobbled up by industries ravenous for their skills.

On the surface this appears to be a happy enough arrangement—freshly trained professionals marching gladly into the welcoming work places of high-paying employers. But things are so good for the bachelor-level engineer that fewer and fewer are willing to go on for advanced degrees, and fewer still are interested in becoming teachers of future engineers. We are, as more than one educator put it, "using up our seed corn" at an alarming rate, and we have already begun to feel the first twinges of the forecasted famine: while double the number of college freshmen listed "engineering" as their major last year as in 1972, many were turned away for lack of space—in fact, 21 of the country's top engineering schools have been forced to restrict enrollment. Those freshmen who do manage to squeeze in are finding classrooms crowded, professors overworked, and educational budgets stretched past their limits, hardly incentives to aspire to an academic career.

"It's an enduring problem, and it's very real," says W. Edward Lear, executive director of the American Society for Engineering Education (ASEE). "There are 1,800 openings on engineering faculties that can't be filled, and 1,000 fewer Ph.D.s graduating in 1980 than in 1973 [a peak year]. Industry takes at least two-thirds of these, so the pool is extremely small." In addition, about one-half of last year's doctorates were awarded to foreign nationals—students from Asia, Africa, South America, and Europe—many of whom have neither the means nor the intention of settling in this country.



Engineering educators say money is the single most important factor in wooing young engineers. Starting salaries for bachelor-level engineers in industry are as high as $30,000 a year; faculty appointments often pay less than $20,000.

Add to this the problem of worn-out and obsolete laboratory equipment (with an average age of 15 years), the dwindling money for academic research, and the uncertainty of tenure, and you have a fairly unattractive picture—so unattractive that only 12 percent of last year's graduating engineers opted for advanced study. And since federal funding for engineering education was cut dramatically by the present administration, the chances of quick improvement are slim.

"In the budget we submitted to President Carter last year, we asked for $111.9 million to be used for training engineering graduate students and upgrading faculty and facilities," says Albert Young, acting deputy director of the Engineering Directorate at the National Science Foundation. "This was reduced to $9.9 million by the current administration. The Senate and the House have reinstated about 20 to 30 percent of the original budget, but whether we'll be able to do something about the faculty shortage problem with the budget we get is an open question."

Young and others suggest that industry take more responsibility for the training and support of future employees, especially if Congress decides that "engineering education is not a federal responsibility." Industry representatives say that they already play a significant role by funding scholarships and work-study programs, but acknowledge that more could be done to upgrade what Edward David, president of Exxon Research and Engineering Co., calls "the dangerously low state of our science and engineering schools." An ad hoc committee funded by eight major manufacturers was formed earlier this year to find "workable solutions to insure that future engineers are properly educated to face the demands of their profession."

ASEE Executive Director Lear suggests that these solutions might include supplementing the salaries of professors and graduate assistants to make them more competitive, creating more endowed chairs for faculty, and establishing joint appointments with industry that offer salaries midway between academic and industrial levels. However, Lear admits that such measures are both expensive and politically sensitive—awarding engineering graduate assistants twice the stipend earned by their counterparts in physics may "cause some friction." Besides, he concludes, "You can't really buy engineering faculty."

Professor Kent Hansen, associate dean of engineering at M.I.T., agrees: "The approach most people seem to be taking is seduction," he says. "I think we should try induction—that is, convincing students of the inherent rewards of academic life."

According to Professor Hansen, the "conventional wisdom" that engineering faculties are not growing and that the number of tenured positions is small is no longer true. "In the 1950s engineering faculties expanded dramatically and many who were hired at that time will soon retire," he says. "In fact, about one-third of our engineering faculty will reach age 65 within the next ten years." Other inducements include the academic's ability to pursue independent research, interact and collaborate freely with graduate students and colleagues, and supplement university wages with consulting fees.

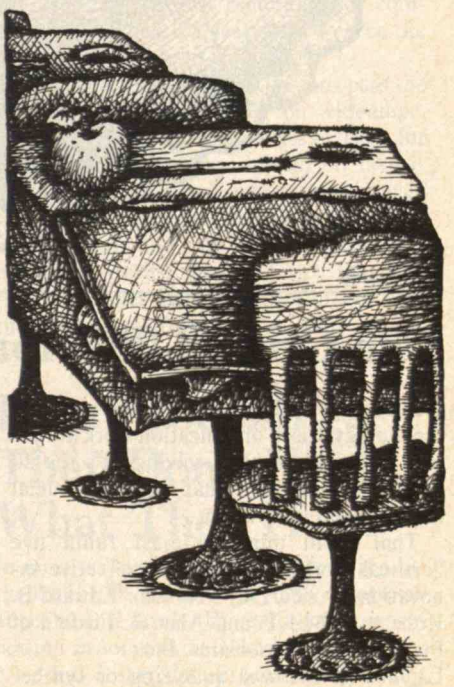
But he draws the line at encouraging engineers without doctorates to fill out the faculty—a suggestion advanced by a number of industry watchers. "By and large, the doctorate has become the union card of academia," Professor Hansen says. "We place heavy emphasis on research, and the doctorate shows a person's ability to accomplish this research on a high level. I have no objection to adjunct faculty coming in to conduct elementary laboratories, but I do object to hiring them to teach courses."

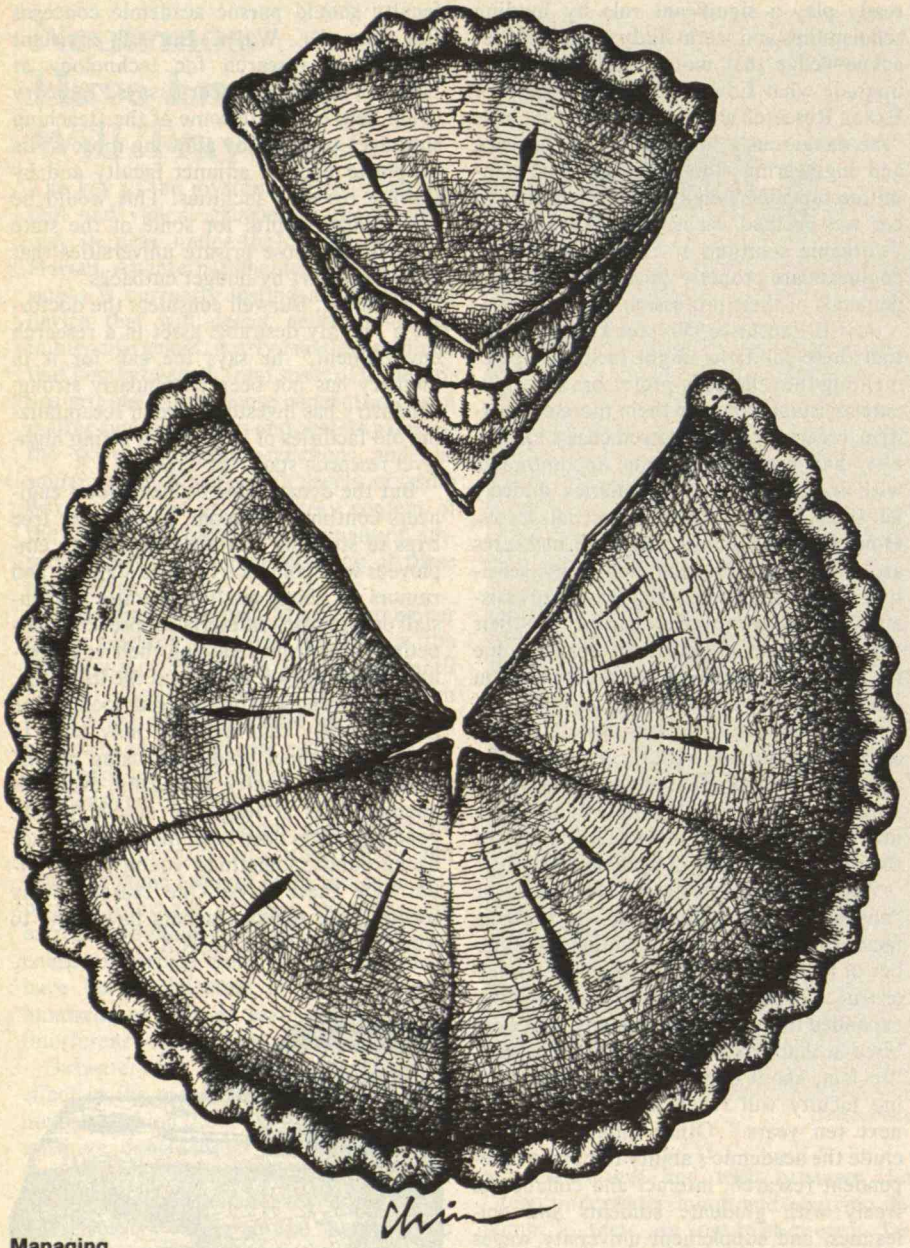
But not everyone agrees that engineering faculty should pursue academic concerns full time. Dr. Wayne Burwell, assistant director of research for technology at United Technologies Corp., says "Industry could help eliminate some of the [teaching shortage] problem by allowing more of its people to become adjunct faculty and by sharing research facilities. This would be particularly helpful for some of the state schools and those private universities that have been hurt by budget cutbacks."

While Dr. Burwell considers the doctorate a "highly desirable asset in a research environment," he says the call for it in industry has not been particularly strong. "Industry has invested more in recapitalizing old facilities of late than in hiring high-level research staff," he says.

But the demand for bachelor-level engineers continues to boom. Firms offer free trips to students and cash bonuses to employees who convince them to sign on, and rumors fly about small companies who install on-premises cafeterias to prevent competing firms from seducing their engineering staff away over burgers at the local deli.

If the trend is not reversed soon, some managers say that industry may have to train high school graduates, using professional staff as faculty. Ironically, even this approach has at least one crucial pitfall: good engineers need solid math and science backgrounds, something young people often lack these days. One reason: many former high school teachers have gone to work for high tech.—*E.R.S.* □





Managing

The Critical 20% for Innovation

Nearly four-fifths of the workers in any technology-based organization work at routine technical problem solving. It's the 20 percent who do more that make the crucial difference in innovation.

That small minority must fulfill five "critical work functions" for effective innovation to occur, say Professor Edward B. Roberts of M.I.T. and Alan R. Fusfeld of Pugh-Roberts Associates, Inc.:

☐ *Idea generation*: analyzing or synthesizing information about markets and technologies to lead to a new product or service.

☐ *Entrepreneurship*: proposing and championing a new technical idea to gain management's approval.

☐ *Project leadership*: planning and directing the jobs and people necessary to turn a new idea into a product or practice.

☐ *Gatekeeping*: collecting and passing along information about markets, technology, and the competition.

☐ *Sponsoring*: behind-the-scenes help and support of those with good ideas, even to the point of advocacy and "bootlegging" of funds.

Some of the critical 20 percent of research and development workers fulfill more than one critical function, and their roles occasionally change. But the important point, note Messrs. Roberts and Fusfeld in the *Sloan Management Review*, is that deficiency in any one area leads to "serious problems in the innovative effort."

Ideas are not generated if the organization is not thinking of new ways of doing things. Leadership is suspect if deadlines are not met. Gatekeeping is inadequate if changes in technology come without warning or "if you suddenly realize that you have just succeeded in reinventing a competitor's wheel." Poor coaching is evident if a product is pushed into application too soon or if research and development people complain about "navigating the bureaucracy."

Most of these critical people in the organization have unique qualities, they say. The idea generator, important especially at the beginning of a project, is innovative, well educated, enjoys working on frontiers, and likely to be a loner. The champion is the entrepreneur—an aggressively capable salesperson whose "drives may be less rational and more emotional than those of a creative scientist." In contrast, an effective project leader is organized, sensitive, and a good planner. A good gatekeeper is an extrovert, a communicator who cultivates information and its sources. The sponsor is likely to be a more experienced, older worker who has "mellowed" to acquire a "softer touch."

The whole idea of deliberately managing these critical functions is a new one, and few technical firms have yet to capitalize on it. The conventional "dual ladder" concept—individuals rising as either scientists or managers in the organization—reflects both "oversimplification and distortion" of the roles needed in an innovative organization. Instead, research and development managers ought to apply the "critical functions" concept to recruiting, job assignment, personnel development, work design, setting objectives, performance measures and rewards, even corporate planning. Indeed, say Messrs. Roberts and Fusfeld, "The way critical functions are encouraged is probably an organization's single most important area of leverage for maintaining and improving effective innovation."—*J.M.* ☐

2006: Crisis of Age, Not Energy

How will the United States of the year 2006—just 25 years from now—be different from the nation of 1981?

Four answers, by four leading members of M.I.T.'s class of 1956 attending their 25th reunion last June:

☐ Dr. Arthur Frank of George Washington University Medical School: The fruits of the "huge medical research enterprise" of the last 30 years will yield "rational cures" for viral diseases, cancer, and heart disease. The result will be "an explosion of old people in the United States."

☐ Russell L. Schweikart, the Apollo astronaut who is now chairman of the California Energy Commission: Our view of ourselves will be revolutionized into a new philosophy of earth as a living organism surrounded by a solar system from which it can draw sustenance and strength.

☐ C. Gordon Bell, vice-president for engineering of Digital Equipment Corp.: Advances in physics, communications, and information-handling techniques will render the transistor obsolete by 1990 and result in the integration of homes and offices for most of us soon thereafter.

☐ Lawrence I. Moss, former president of the Sierra Club who is now a consultant on energy and environmental policy: In 25 years the U.S. "energy crisis" will have melted away. We will have learned that annual increases of 2 to 3 percent in real gross national product can be achieved with "no significant increase in primary energy use in the United States."

Dr. Moss's confidence rests on the power of conservation: there is "no end of options to improve the efficiency of end use (of energy) in a cost-effective way. . . . We are so far from the . . . limits in most sectors of energy use that we could improve efficiencies by 100, 200, even 300 percent."

Dr. Frank began with a dash of cold water: by the 1940s, almost before he and his classmates were born, the basic elements of medical science—the scientific basis for medical care—were established: biochemistry, cell biology, genetics, and others. But these remain largely untapped: the remarkable increase in human longevity of the last 25 years has resulted chiefly from developments in sanitation dating from the 1920s, and the elimination of a few infectious diseases by antibiotics—notably smallpox, polio, pneumonia, and tuberculosis.



It remains for doctors in the next 25 years to capitalize on research since World War II, and it will be a period "as exciting and dramatic as the last 2000 years—since the beginning of anything called medicine," Dr. Frank told his classmates.

With all this progress will come one overriding problem: "15 to 20 million more people over the age of 64 than ever before—a huge army, poorly equipped, poorly financed, overextending any known logistical support . . . a political nightmare."

To Russell Schweikart, the question is pessimism versus optimism—anxiety versus excitement. When we approach space with the latter, we will find in it a wholly new environment for growth and fulfillment. Instead of a civilization limited by its wealth and resources, we will see "new seeds, new life, a new birth . . . a different world."

Gordon Bell finds the way to the future in the past. In the last 25 years, he recalled, computing power has increased by some 20 orders of magnitude. New generations of computers—each capable of 100 times more operations per unit of time than its predecessor with 10 times the memory capacity—now come about every 7 years, and there is no reason to think this progress will stop. Some 2 million people now have jobs as information translators—airline reservation clerks, for example. Even today these jobs could be done at home instead of in offices. And more important, most could be done directly by the people whom the translators now serve. Indeed, speculated Mr. Bell, the biggest roadblock for computers in the next 25 years may well be the inability of people to use them.

How well these prognostications pass the test of time—they're all on videotape, awaiting the return of the class of 1956 for its 50th reunion—may depend on factors about which the speakers were curiously silent. Not one chose to speak of how technology has in the past 25 years been harnessed for destruction, and how they and their colleagues share an opportunity to mold that part of our future, too.—*J.M.* ☐

Data Processing: They Don't Need What They Have

In most companies, data processing is a little like the U. S. mail: everybody complains about it. But surely the quality of data processing in some firms is better than in others—and a few data-processing functions

must occasionally earn high marks from someone.

To study these apparent anomalies, Robert M. Alloway, research associate in the Sloan School of Management at M.I.T., developed a list of 26 criteria for data-processing functions, including technical competence of the staff, cost-effectiveness, responsiveness to user needs, training programs, length of backlogs for new-system requests, and hardware and systems downtime. He then asked data-processing supervisors and general managers in six companies to rate the importance of good performance and their own company's actual performance in each area.

Surprise: judgments of relative importance were the same in all six firms. Technical, operational, and efficiency-oriented aspects were all rated high. User relations and other aspects related to system management were all rated low, with backlog management lowest of all.

Another surprise: data processors and managers alike agreed on their actual performance ratings.

Then a third surprise, the crucial finding: there was "absolutely no correlation" between the relative importance of criteria and performance. For example, data-processing qualitities that everyone agreed were most important were the most poorly performed by everyone.

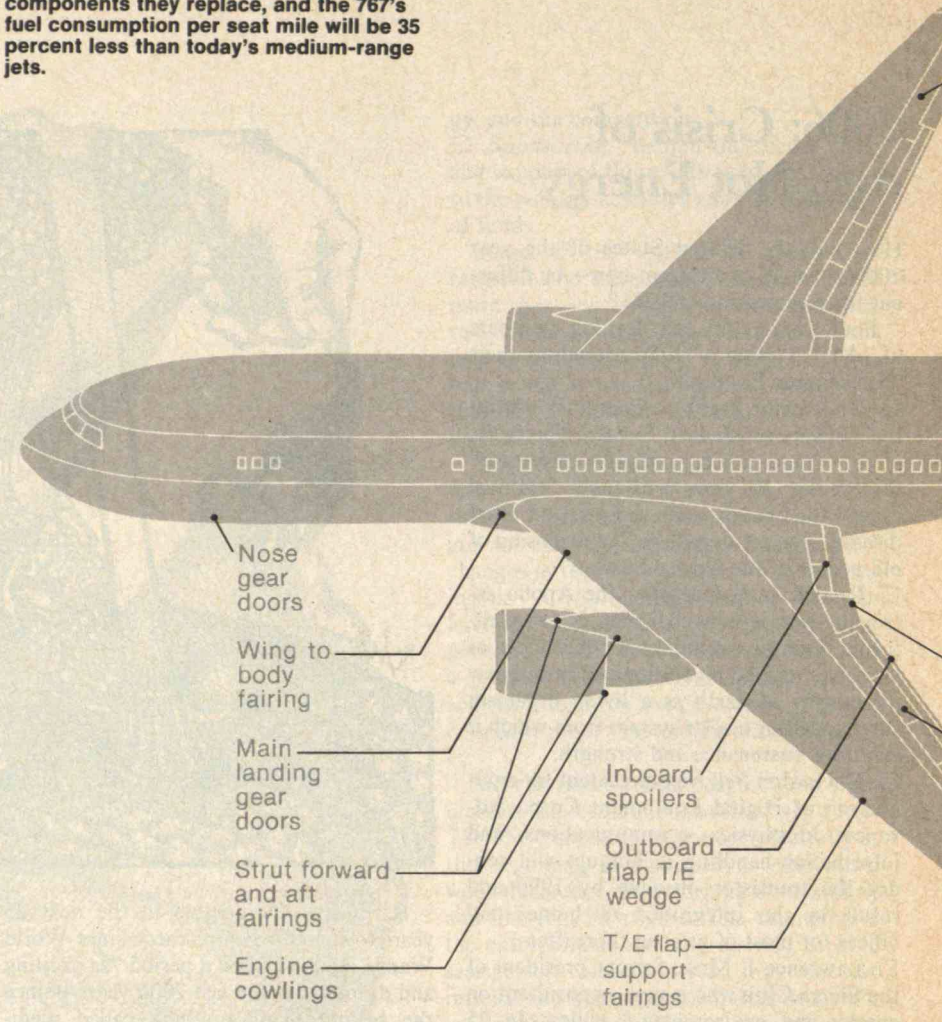
"The heart of the problem lies not in importance or performance disagreements between users and data processors," wrote Dr. Alloway. The difficulty is that both groups "fail to detect any desirable or justifiable relationship between importance and performance." As a result, the most basic managerial rule—to allocate resources to the most important tasks—is clearly being violated," he concludes.

Dr. Alloway's prescription is for a little "prioritizing": let managers and data processors talk out their problems and then work on first things first. But he foresees two difficulties.

☐ In many of the firms, there seemed to be "too many areas of desired improvement for the scarce resources available," and managerial attention was one of the scarcest resources of all.

☐ The problems were—and always will be—moving targets. When one "worst problem" is finally resolved, it will be replaced by another. "Defining success, assessing performance and importance, and mounting efforts to improve are basic, recurring managerial tasks," observes Dr. Alloway.—*J.M.* ☐

Plastics in the sky: graphite-epoxy, Kevlar®, and hybrid composites have a major role in Boeing's new 767 transport due to fly late next year. The composites weigh some 20 to 35 percent less than the components they replace, and the 767's fuel consumption per seat mile will be 35 percent less than today's medium-range jets.



Transportation

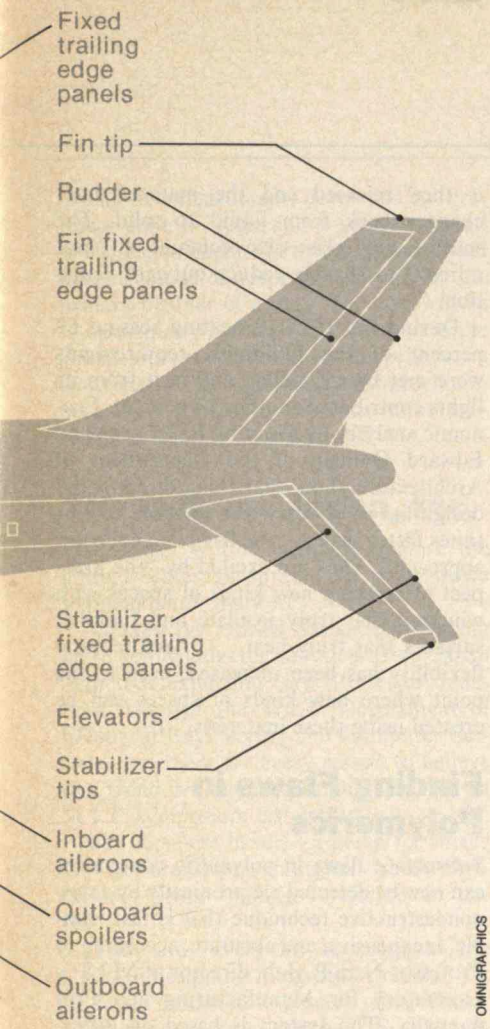
Plastic Aircraft

If 40 percent of an aircraft's load-bearing structure could be made of carbon-fiber-reinforced plastics (CFRPs), material costs could come down by 20 percent, according to T. Sharples of the British Aerospace Aircraft Group, quoted by Willard D. Bascom of the Naval Research Laboratory in the Office of Naval Research publication, *European Scientific Notes*. Though CFRPs are slightly lighter on a volume basis than aluminum—and therefore could offer some energy savings—their big advantage is price: aircraft parts of CFRPs are a bit more expensive than aluminum to make, but assembly costs are lower. Indeed, over 2,800 pounds of carbon-fiber-reinforced plastic will be used in Boeing's new 767 transport which goes into production in 1982, and even more will be in the 757, due in production a year later.

But plastics will not be used in primary, load-bearing structures in either aircraft because there are still too many uncertainties about their performance:

☐ What are the effects of moisture absorption on the mechanical properties of CFRPs exposed to inclement weather? No one is sure. Extremes of temperature and mechanical stress may also cause problems.

☐ What happens to CFRPs when struck by lightning? Once taken seriously, this question is now generally dismissed. But the related question of what happens to other aircraft components when an airplane containing CFRPs is struck by lightning is far from dismissed. The problem is that even low levels of electromagnetic radiation can disable modern electronic circuits. Aluminum provides effective shielding, but CFRPs do not. Even nearby lightning would wipe out much of the integrated circuitry in a plane with CFRPs substituting for substantial quantities of aluminum, according to calculations by B.J.C. Burrows of the



OMNIGRAPHICS

United Kingdom Atomic Energy Authority. On the other hand, G.L. Weinstock of McDonnell Aircraft Co. and other industry representatives who joined Dr. Bascom at a meeting in Lisbon last summer said this danger was overstated; effective shielding materials can be built into CFRPs for use in aircraft.

Yet "very serious problems" remain at the interfaces between aluminum and CFRP parts, where electrical charges accumulate and could lead to destructive radiation and even mechanical damage.

☐ What about erosion by rain of exposed CFRPs? "A serious problem about which virtually nothing is known," Dr. Bascom wrote in his account of the meeting.

He did not say when, but Dr. Bascom concluded that CFRPs are well on their way into commercial aircraft, and "the all-composite aircraft is at least on the technical horizon." However, "no 'show-stoppers' are in sight," said C.L. Blake of Wright-Patterson Air Force Base in Lisbon.—*J.M.* ☐

Last Line

Economics vs. Libertarianism

The world's economic performance in the 1970s may have been disappointing to optimists conditioned by the post-World War II quarter-century, but the potential for global economic growth in the 1980s and 1990s is "not bad," says Professor Paul E. Samuelson of M.I.T. But the capitalism of the next two decades will be very different from that of the first half of the twentieth century, Professor Samuelson warned members of the American Academy of Arts and Sciences early this year.

There are at least six reasons:

☐ An eightfold increase since 1970 in real oil prices, and similar prospective changes in the price of many other raw materials as modern economies "chew up in a decade what nature takes a millenium to lay down."

☐ The flight of manufacturing from the conventional industrialized nations, including the United States, which are turning into "headquarter economies."

☐ The effect of affluence on personal habits of work and play.

☐ U.S. programs of using deficits to fight unemployment and monetary policies to fight inflation—a recipe for a high-consumption, low-investment economy.

☐ The new trend to libertarianism in "today's litigious society." This trend represents "a drag on economic progress" because "a rule of unanimity is a rule for the status quo." For example, however good or bad the economics of nuclear energy, Russia and China may be "the only societies with the luxury of making a choice on the merits."

Indeed, said Professor Samuelson, "the honeymoon is over for the economy"—the next two decades will be a time for the flowering of special interests and the fulfillment of John Adams' warning: "Giving votes to all means that the poorest 51 percent of the population will use their power to reduce the affluence of the richest 49 percent." "Stagflation" and California's "Proposition 19" and Massachusetts' "Proposition 2½" tax-cap amendments are examples of the theory in action in the United States. Although at the end of World War II the U.S. share of the world's gross national product may have been as high as 50 percent, as reconstruction proceeded, spurred by the Marshall Plan and the Soviets' "impressive" achievements, our share of the GNP fell to below 40 percent in the 1950s. Now our share is about 25 percent, and by the 1990s the figure may well be close to 20 percent.

Not bad for a nation with only 6 percent of the world's population, but therein lies a lesson: Whatever global role America can perform with 40 percent of the world GNP, we must reevaluate what our role will be when we have only half that share.—*J.M.* ☐

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LOOK AT WHAT USERS SAY: Samuel C. McCluney, Jr., of Philadelphia writes: *"CALCULATOR CALCULUS IS GREAT! For ten years I have been trying to get the theory of calculus through my head, using home-study courses. It was not until I had your book that it became clear what the calculus was all about. Now I can go through the other books and see what they are trying to do. With your book and a calculator the whole idea becomes clear in a moment, and is a MOST REFRESHING EXPERIENCE. I program some of the iterative problems you suggest and it always GIVES ME A THRILL to see it start out with a wild guess and then approach the limit and stop."*

Professor John A. Ball of Harvard College (author of the book *'Algorithms for RPN Calculators'*) writes: *"I wish I had had as good a calculus course."*

Professor H. I. Freedman of the U. of Alberta, writing in *Soc. Ind. Appl. Math Review*, states: *"There can be no question as to the usefulness of this book...lots of exercises...very clearly written and makes for easy reading."*

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TEAR OUT AND MAIL TODAY

M.I.T. REPORTER

Nuclear War Warning

Four members of the M.I.T. community were among eleven prominent scientists who last summer urged President Ronald Reagan to take "vigorous" action "to stem the growth of the world's nuclear arsenals.

"The greatest legacy your administration could leave to the future peace, security, and prosperity of the United States would be to help halt the arms race in which we are presently engaged," they wrote to the White House. Increasing the world's nuclear arsenals "adds nothing to, indeed perhaps detracts from, the security of the major powers."

Among the signers of the letter: Professor Herman Feshbach, head of the Department of Physics; Professor Francis E. Low, provost; Professor Emeritus Victor F. Weisskopf of the Department of Physics; and Professor Jerome B. Wiesner, president emeritus. □

Transport by Gasohol

A new cooperative program of education and research is now in progress between M.I.T. and GEIPOT, the research and planning arm of the Brazilian Ministry of Transportation. Already an intensive course on the fundamentals of analysis of transportation systems has been taught in Brazil by three M.I.T. faculty, and urban transportation and energy conservation studies have begun in Pôrto Alegre, Brazil's fifth-largest city. The goal is to develop a model for forecasting transportation demand that can be used throughout Brazil. The project has special interest for the M.I.T. Center for Transportation Studies because of Brazil's aggressive energy conservation programs, including emphasis on alcohol-powered motor vehicles. □

Fast Payback on "Direct-Gain" Solar

On the basis of two years of operation, the designers of M.I.T.'s fifth solar-heated building are enthusiastic: its unconventional design—with special interior materials instead of an elaborate collector and storage system to trap solar energy—is effective and economical in New England.

The experimental design uses mirrors to direct sunlight from south-facing windows (covering only 45 percent of the south-facing wall) onto ceiling tiles that contain a phase-change material. The sun's heat increases the temperature of the material and it changes from solid to liquid. Extra heat is then released and the material later changes back from liquid to solid. The south-facing glass also contains a "heat mirror" to sharply reduce outward radiation.

During the 1978-79 heating season, 62 percent of the building's requirements were met by solar heat, and heat from its lights contributed another 13 percent. Economic analyses by Timothy E. Johnson and Edward Quinlan of the Department of Architecture show that this "direct-gain" design has a "payback period three to four times faster than . . . the flat-plate collector approach." They are excited by "the prospect of creating new kinds of spaces with windows that truly insulate and building surfaces that truly heat . . . Architectural flexibility has been increased, even to the point where new kinds of spaces can be created using these materials." □

Finding Flaws in Polymerics

Subsurface flaws in polymeric composites can now be detected electronically by a new nondestructive technique that is fast, simple, inexpensive, and accurate, according to Professor Nam P. Suh, director of M.I.T.'s Laboratory for Manufacturing and Productivity. The system is based on differences in the decay of an electrostatic field applied to a composite caused by voids and impurities within. In the testing process, which can be used on production lines operating at up to 6.4 centimeters per second, an electrostatic charge pattern is applied to one surface of a casting (the opposite surface is held at electrical ground), and later an electrostatic probe is used to register the residual charge pattern. □

How Membranes Pass Water

A new scanning micropipette molecule microscope developed in the Research Laboratory of Electronics may permit observation of water flow through individual cells for the first time.

The secret is a micropipette with a tip one to five micrometers in diameter. When this is scanned over a tissue sample in solution, volatile molecules pass up the micropipette into the vacuum of a mass spectrometer. Variations in the distribution and concentration of the permeating molecules can then be correlated with an image presented in a light microscope.

The new instrument, developed by Professor John G. King and Joseph A. Jarrell in the Department of Physics, is to be used first in a study of water transport across the urinary bladder of a toad. The goal will be to determine which cells are involved in the actual transport and how the process in controlled. The toad bladder was chosen because it appears to replicate some processes in the human kidney. ☐

The U.S. vs. Japan, Inc.

Will Japan win its struggle against the United States for supremacy in the world semiconductor market?

Already the United States is importing more semiconductor products from Japan than it is exporting, says Professor Jonathan Allen of the M.I.T. Department of Electrical Engineering and Computer Science, and there is "every reason to believe that trend is likely to continue," he told an M.I.T. symposium last spring.

The Japanese have a lot going for them:
☐ They are leaders in digital circuit fabrication, giving "infinite attention to detail."
☐ They are "every bit as strong as the U.S." in designing integrated circuits.
☐ Japan produces 40 percent more electrical engineers a year than the U.S., and typical Japanese engineers work a 72-hour week in which they manage to read more of the professional literature than their American counterparts. After an extended Japanese visit, Professor Allen concludes that Japanese engineering training is "excellent."

Though the failure rate of Japanese products is low, Professor Allen says it is the testing process "that is going to determine more than anything else what is going to happen" in the field of very large scale integrated circuits. ☐

SOLUTION TO AUGUST/SEPTEMBER CROSTIC

It is possible to imagine (a proton or neutron) spinning like an ordinary top. The electron and the neutrino, however, have the same spin of one-half h-bar and are still smaller: indeed, they may even be point particles, with no size at all. The meaning of spin angular momentum in such objects is far from certain.

Alan D. Krisch, "The Spin of the Proton," *Scientific American*, May, 1979

Solar Heat in a Cloudy Climate

What to do if you live in one climatic region but want to study solar heating in another?

One answer is now taking shape on the M.I.T. campus—a "crystal pavillion" such as that designed to simulate and then keep itself warm in a climate of the Pacific Northwest or England.

"Benign" climates are characterized by moderate winter temperatures but persistent cloud cover. Because there is so little sun, conventional passive solar-heating systems are unsuccessful.

To simulate the "benign" climate, M.I.T.'s crystal palace is being built with walls of glass on the north, east, and west that admit mainly diffuse and reflected sunlight; no heat will be collected from the south or through the roof. But the expanse of diffuse-lighted glass will be highly insulating—a "heat mirror" glazing system with twice the thermal resistance of ordinary double-glazing, according to architect Timothy E. Johnson. Heat from the diffuse sunlight that enters the house will be collected in floor tiles containing eutectic salt thermal storage material. Mr. Johnson, a research associate in the Department of Architecture, calculates that heat losses will be so low that the reflected light will be adequate to meet heating needs in a typical "benign" climate. The house will be completed this spring and first tested during the 1981-82 heating season. ☐

Aircraft Manufacture

Research in manufacturing technology at M.I.T. received a boost last winter from the Boeing Co.—a $250,000 research program in critical manufacturing and productivity problems of advanced aircraft. William L. Shineman, vice-president and general manager of Boeing's commercial airplane fabrication activities, is a leader of the Industrial Advisory Board of M.I.T.'s Laboratory for Manufacturing and Productivity. ☐

LEARNING HOW TO MANAGE TECHNOLOGY

At M.I.T., the Sloan School of Management and the School of Engineering are jointly training scientists and engineers how to manage technology.

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Consumer Orientation
No. 15 in a Series
Subject: Torsion Bar Suspension as a Means to Reduce Vehicle Weight and Increase Aerodynamic Efficiency.

15 Porsche 911SC

At Porsche, we expect a high-performance car to also be a highly-efficient car. So we design every component to produce maximum output, yet add only minimum weight and require minimum space. A prime example: the torsion bar spring. It is used on all four wheels of the 911SC to improve riding comfort and maintain firm tire-road contact. In addition, compared to a leaf or coil spring, it conserves weight and space, two critical requirements of today's automotive designs. Dr. Ferdinand Porsche first introduced automotive torsion bar springing—nearly 50 years ago.



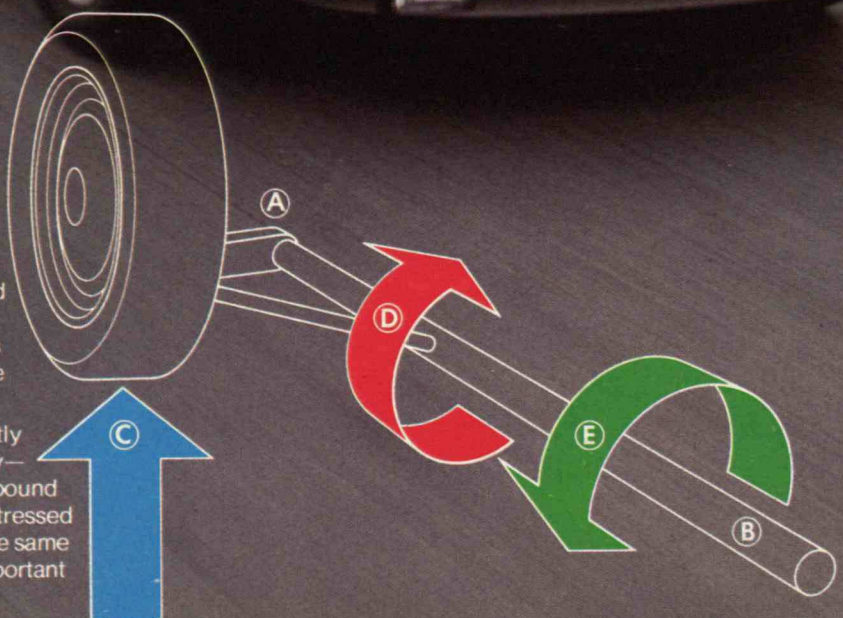
Basically, the torsion bar spring is a long, solid, steel shaft that is anchored at one end (A) to the suspension's control arm and at the other end (B) to the vehicle's frame.

Torsion itself is the twisting action that occurs in the bar when one end (A) is twisted while the other end (B) remains fixed.

When a vertical impact on a wheel (C) is transmitted through the control arm to the torsion bar, the bar twists (D) to absorb the impact. And the bar's natural resistance to twisting quickly restores it (E) to its original position, thus returning the wheel to the road.

A torsion bar can store a significantly higher maximum amount of energy—based on inch pounds energy per pound of spring—than either an equally-stressed leaf or coil spring. Thus, to meet the same application, a torsion bar offers important weight savings.

In addition, compared to a coil spring, a torsion bar requires significantly less space. Thus, on the 911's front suspension (diagrammed here), it can both provide more room for the luggage compartment and minimize airflow restrictions below the vehicle which increases aerodynamic efficiency.



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